PROJECT MANUAL
VOLUME TWO
OSSINING UNION FREE SCHOOL DISTRICT
NEW 7TH & 8TH SCHOOL BUILDING

300 Van Cortlandt Ave

Ossining, New York - 10562

DIVISIONS 21 THROUGH 28

CPL PROJECT NO.: R24.16941.00
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NEW YORK STATE EDUCATION DEPARTMENT PROJECT CONTROL NUMBER(S):
7th & 8th School Building: 66-14-01-03-0-028-001

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 not involve known or suspected ACBM”.

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SECTION 210500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

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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.

G. Piping specialties.

H. Pressure gauges.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

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

1.03 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings; 2024.

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.

E. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.

F. 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; 2025, with Errata.

G. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

I. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2021.

J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.

K. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2021.

L. AWWA C606 - Grooved and Shouldered Joints; 2022.

M. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. NFPA 1963 - Standard for Fire Hose Connections; 2019.

O. UL 405 - Standard for Safety Fire Department Connection Devices; Current Edition, Including All Revisions.

1.04 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 substaintially 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.

1.05 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.

1.06 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.

1.07 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 PIPE SLEEVES

A. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.

B. Plastic, Sheet Metal, or Moisture-Resistant Fiber: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.

C. Pipe 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.

2.04 ESCUTCHEONS

A. Manufacturers:
   1. Fire Protection Products, Inc: www.fppi.com/#sle.com/#sle.
   2. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
   3. Victaulic
   4. Viking Group Inc: www.vikinggroupinc.com/#sle.
   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.

2.05 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
   1. Manufacturers:
      a. AFCON, a brand of Anvil International: www.anvilintl.com/#sle.
      b. FNW: www.fnw.com/#sle.

B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
   1. Manufacturers:
      a. AFCON, a brand of Anvil International: www.anvilintl.com/#sle.
      b. FNW: www.fnw.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

D. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

E. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.

F. Vertical Support: Steel riser clamp.
   1. Manufacturers:
      a. Anvil International: www.anvilintl.com/#sle.

G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   1. Manufacturers:
      a. Anvil International: www.anvilintl.com/#sle.

H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.06 MECHANICAL COUPLINGS

A. Manufacturers:
1. Anvil International: www.anvilintl.com/#sle.
2. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
3. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
4. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.

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.

2.07 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
1. Activate electric alarm.
2. Test and drain valve.
3. Replaceable internal components without removing valve from installed position.
4. Manufacturers:
a. Victaulic Company; Series 751 with Series 760 motor alarm: www.victaulic.com/#sle.

B. Test Connections:
1. Inspector's Test Connection for Preaction and Dry Pipe Systems:
a. Provide test connections approximately 6 feet above floor for each or portion of each sprinkler system equipped with an alarm device, located at most remote part of each system.
b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
c. Supply discharge orifice with same size as corresponding sprinkler orifice.
d. Limit vertical height of exterior wall penetration to 2 feet above finished grade.
e. Manufacturers:
1) AGF Manufacturing: www.agfmfg.com/#sle.

C. Fire Department Connections:
1. Type: Exposed, projected wall mount made of corrosion-resistant metal complying with UL 405.
a. Inlets: Two-way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or authority having jurisdiction. Brass caps with gaskets, chains, and lugs.
b. Configuration: Horizontal.
c. Rated Working Pressure: 175 psi.
d. Finish: Chrome.
e. Sleeve: Brass, 18-inch height.
f. Signage: Raised or engraved lettering 1 inch, minimum, indicating system type.
g. Manufacturers:
1) Elkhart Brass Manufacturing Company, Inc: www.elkhartbrass.com/#sle.
2) Fire End & Croker Corporation: www.croker.com/#sle.

D. Supervisory Switches:
   1. Manufacturers:
      a. Potter Electric Signal Company, LLC; CoilKeeper Solenoid Supervisory Switch: www.pottersignal.com/#sle.

2.08 PRESSURE GAUGES

A. Manufacturers:
   1. AGF Manufacturing; _____: www.agfmfg.com/#sle.
   2. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
   3. Moeller Instrument Company, Inc; _____: www.moellerinstrument.com/#sle.
   4. Omega Engineering, Inc: www.omega.com/#sle.
   5. Winters Instruments: www.winters.com/#sle.

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 suppresssion piping shall be indepentanly 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.

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 210500

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 078400 - Firestopping.

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

C. Section 211100 - Facility Fire-Suppression Water-Service Piping.

1.03 ABBREVIATIONS AND ACRONYMS

A. EPDM: Ethylene-propylene diene monomer.

B. NRS: Non-rising stem.

C. OS&Y: Outside screw and yoke.

D. PTFE: Polytetrafluoroethylene.

1.04 REFERENCE STANDARDS

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

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.

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.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.07 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.

1.08 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 appliable.
   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 210523

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. Manufacturers:
   1. Brimar Industries, Inc: www.pipemarker.com/#sle.
   2. Kolbi Pipe Marker Company: www.kolbipipemarkers.com/#sle.
   3. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.

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

2.03 TAGS

A. Manufacturers:
   1. Advanced Graphic Engraving, LLC: 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 Company: www.kolbipipemarkers.com/#sle.
   6. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.

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

2.04 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 Company: 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.

PART 3 EXECUTION

3.01 PREPARATION

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

B. Prepare surfaces in accordance with Section 099123 for stencil painting.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. 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 210553

SECTION 211100
FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water pipe.

B. Valves.

C. Fire department connections.

1.02 RELATED REQUIREMENTS

A. Section 210500 - Common Work Results for Fire Suppression.

B. Section 211300 - Fire-Suppression Sprinkler Systems.

1.03 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

F. ASTM B32 - Standard Specification for Solder Metal; 2020.

G. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

H. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

I. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2026.

J. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2026.

K. AWWA C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipe and Fittings; 2025.

L. AWWA C206 - Field Welding of Steel Water Pipe; 2023.

M. AWWA M11 - Steel Pipe - A Guide for Design and Installation; 2017, with Addendum (2019).

N. CDA A4015 - The Copper Tube Handbook; Current Edition.

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

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of double check valve with size, location and installation of service utilities.

1.05 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 manufacturer's 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. Project Record Documents:

1. Record actual locations of piping mains, valves, connections, fire hydrants, free-standing fire department connections, underground manholes and vaults, valve boxes, thrust restraints, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALITY ASSURANCE

A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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 work of the type specified and with at least five years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

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

1.07 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.

1.08 FIELD CONDITIONS

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

1.09 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 WATER PIPE

A. Steel Pipe: ASTM A53/A53M, Grade B, Type F. Provide standard weight, zinc-coated, and listed piping.
   1. Fittings: Comply with ASME B16.3 Class 150, zinc-coated, threaded or ASME B16.4 Class 125, zinc-coated.
   2. Mechanically Factory Applied Protective Materials:
      a. Clean by wire brushing and solvent cleaning.
      b. Apply one coat of coal-tar primer and two coats of coal-tar enamel complying with AWWA C203.
      c. Protect threaded pipe ends and fittings prior to coating.

B. Copper Tubing: Listed, ASTM B88 (ASTM B88M), Type K (A), 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.
   3. Mechanical Press Sealed Fittings: Double-pressed type and approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.

a. Manufacturers:
1) FNW; Copper Press: www.fnw.com/#sle.

C. Copper Tube: Listed, ASTM B88 (ASTM B88M), Type K (A) annealed.
1. Fittings: ASME B16.22, wrought copper.
2. Joints: Solder, lead free, ASTM B32 HB alloy (95-5 tin-antimony), or tin and silver.
3. Casing: Closed glass cell insulation.

2.02 VALVES

A. General:
1. Manufacturer's name and pressure rating marked on valve body.
2. Minimum Compliance: UL (DIR) listed and labeled.
3. Maximum Inlet Pressure: 400 psi.
4. Maximum Service Temperature: 180 degrees F.
5. Valve Coatings:
a. Internally: 4 mils, 0.004 inch epoxy, minimum.
b. Externally: Epoxy base then fire red enamel paint or heat-fused red epoxy paint.

B. Detector Check with Water Meter:
1. Manufacturers:
a. Badger Meter, Inc: www.badgermeter.com/#sle.
b. FEBCO: www.febcoonline.com/#sle.
c. Watts Water Technologies, Inc: www.wattswater.com/#sle.
2. 4 inch NPS to 10 inch NPS:
a. Description: Check valve, water meter, by-pass piping, and isolation valves designed to measure both low flow and high water volume usage.
1) Valve Body: Comprised of epoxy coated stainless steel, ductile iron, or cast iron.
2) Valve Ends: Flanged.

2.03 FIRE DEPARTMENT CONNECTIONS:

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 INSTALLATION

A. General Requirements:
1. Location of Water Lines:
a. Terminate the work covered by this Section at a point approximately 5 feet from the building unless indicated otherwise.
b. Do not install water line closer horizontally than 10 feet from any sewer line unless indicated otherwise.
c. Water Piping Parallel With Sewer Piping:
1) Install water piping minimum 10 feet horizontally (measured edge-to-edge) from a sewer or sewer manhole where possible.
2) Bottom (Invert) of Water Piping:

(a) Minimum 18 inches above top (crown) of sewer piping.
(b) Where this vertical separation of 18 inches above top (crown) of sewer piping cannot be obtained, the installation will be acceptable only when sewer piping is constructed of AWWA approved water pipe and pressure tested in place without leakage prior to backfilling.

2. Sleeving:
   a. Sleeve water piping where piping is required to be installed within 3 feet of existing structures.
   b. Provide ductile iron or Schedule 40 steel sleeves.
   c. Fill annular space between pipe and sleeves with mastic.
   d. Install water pipe and sleeve without damaging structures or causing settlement or movement of foundations or footings.
3. Pipe Laying and Jointing:
   a. Remove fins and burrs from pipe and fittings.
   b. Prior to placing in position, clean pipe, fittings, valves, and accessories, and maintain in clean condition.
   c. Provide proper facilities for lowering pipe sections into trenches.
   d. Dropping or dumping of piping, fittings, valves, or any other water line material into trenches is not permitted.
   e. Cut pipe in a neat, workmanlike manner accurately to length established at the site and work into place without forcing or springing.
   f. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material.
   g. Wedging or blocking between bells and spigots will not be permitted.
   h. Install bell-and-spigot pipe with the bell end pointing in the direction of laying.
   i. Grade the pipeline in straight lines avoiding the formation of dips and low points.
   j. Support piping at proper elevation and grade.
   k. Secure firm, uniform support.
   l. Wood support blocking will not be permitted.
   m. Install pipe so that the full length of each pipe section and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings.
   n. Provide anchors and supports where indicated and necessary for fastening work into place.
   o. Provide proper provisions for expansion and contraction of pipelines.
   p. Keep trenches free of water until joints have been properly made.
   q. Close open ends of piping temporarily with wood blocks or bulkheads at the end of each workday.
   r. Do not install pipe during unacceptable trench conditions or inclement weather.
   s. Minimum Depth of Pipe Cover: Not less than 2-1/2 feet.
4. Connections to Existing Water Lines:
   a. Ensure minimal interruption of service on the existing line.
   b. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.
5. Penetrations:
   a. Provide ductile-iron or Schedule 40 steel for pipes passing through walls of valve pits and structures.
   b. Fill annular space between sleeves and walls with rich cement mortar.
   c. Fill annular space between pipe and sleeves with mastic.

B. Special Requirements:
1. Steel Piping:
   a. Jointing:

1) Bell-and-Spigot: Make rubber-gasketed, bell-and-spigot joints with the gaskets previously specified for this type of joint, using an approved lubricant, all in accordance with the pipe manufacturer's recommendations.
2) Welded: Make welded joints in accordance with AWWA C206 and install in accordance with AWWA M11.
3) Sleeve-Type Mechanical Coupling: Assemble sleeve-type mechanical coupling joints in accordance with the coupling manufacturer's recommendations.

b. Allowable Offsets:
c. Pipe Anchorage:
1) Provide concrete thrust blocks (reaction backing) for pipe anchorage, except where metal harness is indicated.
2) Thrust blocks to be in accordance with the recommendations for thrust restraint in AWWA M11, except that size and positioning of thrust blocks are to be as indicated.
3) Use ASTM C94/C94M concrete having a minimum compressive strength of 2500 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2-1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.
4) Metal Harness:
(a) Provide in accordance with the recommendations for joint harnesses in AWWA M11, except as otherwise indicated.
(b) Fabricated by the pipe manufacturer and furnished with the pipe.

2. Copper Piping:
a. Install in accordance with the Copper Development Association's Copper Tube Handbook and manufacturer's recommendations - CDA A4015.
b. Bed piping in 6 inches of sand.

C. Valves:
1. Set valves on solid bearing.
2. Center and plumb valve box over valve.
3. Set box cover flush with finished grade.

3.04 SERVICE CONNECTIONS

A. Provide fire water service to Local Authority Having Jurisdiction requirements with reduced pressure backflow preventer and water meter with by-pass valves and sand strainer.

B. Provide sleeve in retaining wall for service main. Support with reinforced concrete bridge. Caulk enlarged sleeve watertight.

C. Anchor fire service main to interior surface of foundation wall.

D. Provide 18 gauge, 0.0478 inch galvanized sheet metal sleeve surrounding service main to 6 inches above floor and 6 feet minimum below grade. Size for 2 inches minimum of glass fiber insulation stuffing.

3.05 FIELD QUALITY CONTROL

A. Field Tests and Inspections:
1. See Section 014000 - BSD Quality Requirements for additional requirements.
2. Provide all labor, equipment, and incidentals required for field testing, except that water and electric power needed for field tests will be furnished as set forth in Section 015100 - Temporary Utilities.
3. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently and at least 5 days after placing of concrete.
4. Fill pipeline 24 hours before testing and apply test pressure to stabilize system, using only potable water.

5. Pressure test piping to ____ psi.
6. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
7. Prepare reports of testing activities.

3.06 CLEANING

A. See Section 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

B. Upon completion of the installation of water lines and appurtenances, remove and haul away all surplus material, including debris resulting from the work.

3.07 CLOSEOUT ACTIVITIES

A. See Section {52} - {52} for closeout submittals.

B. See Section {3326} - {3326} for additional requirements.

END OF SECTION 211100

SECTION 211300
FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. System design, installation, and certification.

C. Fire department connections.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 210500 - Common Work Results for Fire Suppression: Pipe and fittings.

C. Section 210523 - General-Duty Valves for Water-Based Fire-Suppression Piping.

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

E. Section 213000 - Fire Pumps.

F. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 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.

F. UL 405 - Standard for Safety Fire Department Connection Devices; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 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.

1.06 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.

1.07 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 OWNER-FURNISHED PRODUCTS

A. New Products: _____.

2.02 MANUFACTURERS

A. Sprinklers, Valves, and Equipment:
   1. Anvil International: www.anvilintl.com/#sle.
   2. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
   3. Viking Corporation: www.vikinggroupinc.com/#sle.
   4. Victaulic
   5. Reliable
   6. Substitutions: See Section 016000 - Product Requirements.

2.03 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for building areas noted.

B. Occupancy: Ordinary hazard, Group 1; 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.

2.04 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: www.tyco-fire.com/#sle.

B. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

C. Storage Sprinklers: Pendant type with guard.
   1. Response Type: Standard.
   2. Coverage Type: Standard.
   3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

D. Guards: Finish to match sprinkler finish.

E. Spray Nozzles: Brass with solid cone discharge, 30 degrees of arc with blow-off dust cap.
   1. Finish: Brass.

F. 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; _____: www.anvilintl.com/#sle.
      b. Victaulic Company; Vic-Flex: www.victaulic.com/#sle.

2.05 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.
   3. Replaceable internal components without removing valve from installed position.
   4. Manufacturers:
      a. Victaulic Company; Series 751 with Series 760 motor alarm: www.victaulic.com/#sle.

B. Backflow Preventer: Double check valve assembly backflow preventer with drain and OS & Y gate valve on each end.

C. Test Connections:
   1. Inspector's Test Connection:

a. Route test connection to an janitor sink, accepting full flow without negative consequences.

2. Backflow Preventer Test Connection:
   a. Provide downstream of the backflow prevention assembly, listed hose valves with 2.5 inch National Standard male hose threads with cap and chain.
   b. Furnish one valve for each 250 gpm of system demand or fraction thereof.
   c. Provide permanent sign reading "Test Valve" in accordance with Section 210553.

D. Fire Department Connections:
   1. Type: Flush, wall mount made of corrosion resistant metal complying with UL 405.
      a. Configuration: Horizontal.
      b. Rated Working Pressure: 175 psi.
      c. Manufacturers:
         1) Elkhart Brass Manufacturing Company, Inc: www.elkhartbrass.com/#sle.
         2) Fire End & Croker Corporation: www.croker.com/#sle.

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. Install guards on sprinklers where indicated.

I. Hydrostatically test entire system.

J. 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: Light Hazard.
   2. Warehouse, Mechanical, Storage rooms: Ordinary Hazard, Group 2.

END OF SECTION 211300

SECTION 220500
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Mechanical sleeve seals.
   4. Sleeves.
   5. Escutcheons.
   6. Grout.
   7. Equipment installation requirements common to equipment sections, including electrical disconnects.
   8. Painting and finishing.
   9. Concrete bases.
   10. Supports and anchorages.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. Provide: To supply, furnish, install and connect, ready for safe and regular operation of the system or equipment.

G. Install: To erect, mount and connect complete, with related accessories.

H. Supply, Furnish: To purchase, procure, acquire and deliever complete, with related accessories.

I. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

J. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. 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 distruption
   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 responsiblity 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 suce 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 220500

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SECTION 220513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Single phase electric motors.

C. Three phase electric motors.

D. Electrical Disconnects

1.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015, with Errata (2026).

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.

1.03 QUALITY ASSURANCE

A. Comply with NFPA 70.

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 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Refer to Section 260583 for required electrical characteristics.

B. 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.

C. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

D. 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.

E. 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.

2.02 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

C. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.03 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Multiple Speed: Through tapped windings.

C. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.04 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. 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.

C. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

D. 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. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

C. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.

D. Insulation System: NEMA Class B or better.

E. 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.

F. 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.

G. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

H. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.06 ELECTRICAL DISCONNECT

A. Provide required electrical disconnect for all equipment, sized and rated for each associated piece of equipment. Coordinate with electrical contract for power connection.

END OF SECTION 220513

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; 2024.

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

2.03 SLEEVE-SEAL SYSTEMS

A. Manufacturered 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. Characterictics: Non shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28 day compressive strength.

D. Packaging: Premix and factory packaged.

3.01 PIPE-SLEEVE SEALS

PART 3 EXECUTION

4.01 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.

4.02 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.

4.03 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 220517

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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. Gas meters.

C. Liquid-in-glass thermometers

D. Thermowells

E. Dail type pressure gages

F. Gage Attachments

G. Test Plugs.

H. Pressure gauges.

I. Thermometers.

1.03 RELATED REQUIREMENTS

A. Section 221005 - Plumbing Piping

1.04 REFERENCE STANDARDS

A. AGA/ANSI B109 Set - INCLUDES ANSI B109.1, ANSI B109.2, ANSI B109.3, ANSI B109.4; 2000.

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 C702 - Cold-Water Meters -- Compound Type; 2024.

F. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012, with Addendum (2018).

G. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

H. 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. Manufacturers:
   a. Badger Meter, Inc: www.badgermeter.com/#sle.
   b. Sensus, a Xylem brand: www.sensus.com/#sle.
   c. Zenner USA: www.zennerusa.com/#sle.
2. Utility Connection Size: 3 inch flanged.
3. Maximum Unidirectional Water Flow Capacity: As indicated on drawings.
4. Lead-free bronze alloy case, polymer-based cap, and hermetically sealed register.
5. Pressure and Temperature: Up to 150 psi and 100 degrees F.
6. 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 GAS METERS

A. Diaphragm Gas Meters:
   1. Manufacturers:
      a. Elster American Meter: www.elster-americanmeter.com/#sle.
      b. Itron, Inc: www.itron.com/#sle.
      c. Norgas, Inc: norgas.com/#sle.
   2. Maximum Operating Line Pressure: 10 psi.
   3. Gas Flow Rate: Natural gas with flow rate as indicated on drawings.
   4. Rangeability and Accuracy: 100 to 1 at plus or minus 1 percent.
   5. Temperature Compensation: -30 to 140 degrees F.
   6. B109.1/B109.2 of AGA/ANSI B109 Set, coated aluminum case with security seals, female threaded piping connection, and hermetically sealed register.

B. Rotary Gas Meters:
   1. Manufacturers:
      a. Elster American Meter: www.elster-americanmeter.com/#sle.
      b. Norgas, Inc: norgas.com/#sle.
   2. Maximum Operating Line Pressure: Limit of 285 psi.
   3. Gas Flow Rate: Natural gas with flow rate as indicated on drawings.
   4. Rangeability and Accuracy: 80 to 1 at plus or minus 2 percent.
   5. Service Temperature Range: Minus 40 to 140 degrees F.
   6. B109.3 of AGA/ANSI B109 Set, coated aluminum case with security seals, flanged piping connection, low pressure drop, hermetically sealed register, pressure compensation, restrictive orifice plate, reverse flow, and temperature compensation .

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that my be incorporated into the work include, but not limited to, the following;
   1. Palmer Wahl Instrument Group.
   2. Tel-Tru Manufacturing Company
   3. Weiss Instruments, Inc.
   4. Winters Instruments - US
   5. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
   6. FMC Technologies: www.fmctechnologies.com/#sle.
   7. Venture Measurement, a Danaher Corporation Company: www.venturemeasurement.com/#sle.
   8. Substitutions: See Section 016000 - Product Requirements.

2.03 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.

2.04 THERMOWELLS

A. Manufacturers:
1. Venture Measurement, a Danaher Corporation Company: www.venturemeasurement.com/#sle.

B. Standard: ASME B40.200.

C. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

D. Material for Use with Copper Tubing: CNR or CUNI.

E. Type: Stepped shank unless straight or tapered shank is indicated.

F. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.

G. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw thread.

H. Bore: Diameter required to match thermometer bulb or stem.

I. Insertion Length: Length required to match thermometer bulb or stem.

J. Lagging Extension: Include on thermowells for insulated piping and tubing.

K. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.05 PRESSURE GAUGES

A. Manufacturers:
1. Ashcroft, Inc: www.ashcroft.com/#sle.
2. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
3. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
4. Omega Engineering a subsidiary of Spectris, Plc; [_____]: www.omega.com/#sle.
5. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
6. Winters Instruments: www.winters.com/#sle.
7. 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 appliable.

2.06 THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
2. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
3. Watts Water Technologies, Inc: www.watts.com/#sle.
4. Weiss Instruments, LLC: www.weissinstruments.com/#sle.
5. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.

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.

2.07 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 EXAMINATION

A. Verification of Conditions: Verify Utility Service Provider piping readiness to receive meter.

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

3.02 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.

3.03 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

3.04 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 220519

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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 (Reapproved 2025).

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. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

Q. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

R. 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 angle, ball, or butterfly.
   4. Swing Check (Pump Outlet):
      a. 2 inch and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
      b. 2-1/2 inch and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.

C. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.

D. Required Valve End Connections for Non-Wafer Types:
   1. Steel Pipe:
      a. 2 inch and Smaller: Threaded ends.
      b. 2-1/2 inch to 4 inch: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
   2. Copper Tube:
      a. 2 inch and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
      b. 2-1/2 inch to 4 inch: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.

E. Low Pressure, Compressed Air Valves 150 psi or Less:
   1. 2 inch and Smaller:
      a. Bronze: Provide with solder-joint ends.
   2. 2-1/2 inch and Larger:
      a. Iron, 2-1/2 NPS to 4 NPS: Provide with flanged or Welded ends.

F. Domestic, Hot and Cold Water Valves:
   1. 2 inch and Smaller:
      a. Ball: Two piece, full port, brass with brass trim.
      b. Bronze Swing Check: Class 125, bronze disc.
   2. 2-1/2 inch and Larger:
      a. Iron Grooved-End Butterfly: 175 CWP.
      b. Iron Swing Check: Class 125, metal seats.

2.03 GENERAL REQUIREMENTS

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

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:

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

E. Valve-End Connections:
   1. Threaded End Valves: ASME B1.20.1.
   2. Solder Joint Connections: ASME B16.18.

3. Grooved End Connections: AWWA C606.

F. General ASME Compliance:
1. Solder-joint Connections: ASME B16.18.
2. Building Services Piping Valves: ASME B31.9.

G. Potable Water Use:
1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.

H. Source Limitations: Obtain each valve type from a single manufacturer.

2.04 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110.
2. WSP Rating: 150 psi.
3. WOG Rating: 600 psi.
4. Body: Forged bronze or dezincified-brass alloy.
5. Ends Connections: Pipe thread or solder.
6. Seats: PTFE.
7. Stem: Stainless steel, blowout proof.
8. Ball: Stainless steel, vented.
9. Manufacturers:
a. Apollo Valves; _____: www.apollovalves.com/#sle.
b. Watts
c. Nibco - Equal to 585HP-66-LF

2.05 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. 150 psi for sizes 14 to 24 inch.
b. 250 psi for sizes 2 to 12 inch.
c. 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.

2.08 BRASS, HORIZONTAL SWING CHECK VALVES

A. Class 125, Threaded or Soldered End Connections:
   1. WOG Rating: 200 psi.
   2. Body: Forged brass.
   3. Disc: Forged brass.
   4. Hinge-Pin, Screw, and Cap: Forged brass.

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 220523

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SECTION INCLUDES

A. Prefabricated trapeze-framed systems.

B. Strut systems for pipe or equipment support.

C. Beam clamps.

D. Pipe hangers.

E. Pipe rollers and roller supports.

F. Pipe supports, guides, shields, and saddles.

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 A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

B. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

E. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2025.

F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.

G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).

H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

K. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2025.

M. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

N. MFMA-4 - Metal Framing Standards Publication; 2004.

O. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

P. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

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

R. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

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.
   1. Fiberglass Strut Channel Framing Systems: Include requirements for strength derating according to ambient temperature.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.09 QUALITY ASSURANCE

A. Comply with applicable building code.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.

B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.

C. Materials for Metal Fabricated Supports: Comply with Section 055000.
   1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
   2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.

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

2.02 PREFABRICATED TRAPEZE-FRAMED SYSTEMS

A. Prefabricated Trapeze-Framed Metal Strut Systems:
   1. Manufacturers:
      a. Anvil International, LLC: www.asc-es.com/#sle.
      b. Custom Strut and Roll Forming, LLC: www.customstrut.com/#sle.
      c. Gripple, Inc; Fast Track - Standard: www.gripple.com/#sle.
      d. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
   2. Strut Channel or Bracket Material:
   3. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

B. Prefabricated Trapeze-Framed Fiberglass Strut Systems:
   1. Manufacturers:
      a. Enduro Composites: www.endurocomposites.com/#sle.
   2. MSS SP-58 type 59, prefabricated continuous-slot fiberglass strut channel, associated fittings, and related accessories.
   3. Flammability: Fire retardant with NFPA 101, Class A flame spread index (maximum of 25) when tested in accordance with ASTM E84; self-extinguishing in accordance with ASTM D635.

2.03 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

A. Strut Channels:
   1. Manufacturers:
      a. ABB Installation Products: electrification.us.abb.com/#sle.
      b. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
      c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
   2. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
   3. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

B. Hanger Rods:

1. Threaded zinc-plated steel unless otherwise indicated.
2. Minimum Size, Unless Otherwise Indicated or Required:

C. Channel Nuts:
1. Manufacturers:
a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
b. FNW; 7821: www.fnw.com/#sle.
c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
2. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

2.04 BEAM CLAMPS

A. Manufacturers:
1. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
2. FNW; 7201: www.fnw.com/#sle.
3. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.

B. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

C. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2.05 PIPE HANGERS

A. Band Hangers, Adjustable:
1. Manufacturers:
a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
b. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
2. MSS SP-58 type 7 or 9, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.

B. J-Hangers, Adjustable:
1. Manufacturers:
a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
b. FNW; 7025: www.fnw.com/#sle.
c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
2. MSS SP-58 type 5, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.

C. Clevis Hangers, Adjustable:
1. Manufacturers:
a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
b. FNW; 7005: www.fnw.com/#sle.

2.06 PIPE CLAMPS

A. Riser Clamps:
1. Manufacturers:
a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
b. FNW; 7020: www.fnw.com/#sle.
c. nVent Caddy, a brand of nVent: www.erico.com/#sle.
2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
3. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

2.07 PIPE ROLLERS AND ROLLER SUPPORTS

A. Manufacturers:
   1. ASC Engineered Solutions: www.asc-es.com/#sle.
   2. FNW; 7902: www.fnw.com/#sle.
   3. nVent Caddy, a brand of nVent: www.erico.com/#sle.

B. MSS SP-58 type 43 based on required load, nonconductive and corrosion resistant.

C. Material: Zinc plated ASTM A36/A36M carbon steel or ASTM A47/A47M malleable iron.

2.08 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

A. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

B. Stanchions:
   1. Manufacturers:
      a. Anvil International: www.anvilintl.com/#sle.
      b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      c. nVent Caddy, a brand of nVent: www.erico.com/#sle.
   2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
   3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.

C. Pipe Supports:
   1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
   2. Liquid Temperatures Up to 122 degrees F:
      a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.
      b. Support From Below: MSS SP-58 types 35 through 38.

D. Pipe Supports, Thermal Insulated:
   1. General Requirements:
      a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
      b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
      c. Provide pipe supports for 1/2 to 30 inch iron pipes.
      d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by 360 degree, PVC jacketing.
   2. PVC Jacket:
      a. Pipe insulation protection shields to be provided with ball bearing hinge and locking seam.
      b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
      c. Minimum Thickness: 60 mil, 0.06 inch.

E. Copper Pipe Supports:
   1. Manufacturers:
      a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      b. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

F. Overhead Pipe Supports:
   1. Manufacturers:
      a. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

b. nVent Caddy, a brand of nVent: www.erico.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

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

B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

G. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Secure fasteners according to manufacturer's recommended torque settings.

I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - 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 220529

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; 2025.

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: www.pipemarker.com/#sle.
   2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
   3. Seton Identification Products: www.seton.com/#sle.

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. 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: www.seton.com/#sle.
7. 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 STENCILS

A. Manufacturers:
1. Brady Corporation: www.bradycorp.com/#sle.
2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
3. Insite Solutions, LLC: www.stop-painting.com/#sle.
4. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com/#sle.
5. Seton Identification Products: www.seton.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

B. Stencil Paint: As specified in Section 099123, semi-gloss enamel, colors complying with ASME A13.1.

2.05 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: www.seton.com/#sle.

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 220553

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SECTION 220716
PLUMBING EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cellular glass insulation.

B. Cellular melamine insulation.

C. Flexible glass fiber insulation.

D. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 220553 - Identification for Plumbing Piping and Equipment.

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, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

D. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.

E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

F. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.

G. ASTM C1410 - Standard Specification for Cellular Melamine Thermal and Sound-Absorbing Insulation; 2017 (Reapproved 2023).

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2025.

I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

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

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

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 three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 CELLULAR MELAMINE INSULATION

A. Manufacturers:

B. Insulation: Flexible preformed open-cell polymeric foam tubing, slit lengthwise for installation, complying with applicable requirements of ASTM C1410.
   1. K Value: ASTM C177; 0.25 at 75 degrees F.
   2. Minimum Service Temperature: Minus 40 degrees F.
   3. Maximum Service Temperature: 350 degrees F.
   4. Factory-Applied Jacketing Material: Paper/Foil/Scrim.
   5. Jacketing material to be field-applied.

2.03 FLEXIBLE GLASS FIBER INSULATION

A. Manufacturers:
   1. CertainTeed Corporation: www.certainteed.com/#sle.
   2. Johns Manville Corporation: www.jm.com/#sle.
   3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.

B. Insulation: ASTM C553; flexible, noncombustible.
   1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum Service Temperature: 450 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.

2.04 CELLULAR GLASS INSULATION

A. Manufacturers:
   1. Owens Corning Corporation; FOAMGLAS: www.ocbuildingspec.com/#sle.

B. Pipe and Tube Insulation: ASTM C552, Type II, Grade 6.
   1. K Value: 0.35 at 100 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Service Temperature Range: From 250 degrees F to 800 degrees F.
   3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
   4. Water Absorption: 0.5 percent by volume, maximum.

5. Density: 6.12 pcf, minimum.

2.05 JACKETING AND ACCESSORIES

A. PVC Plastic:
   1. Manufacturers:
      a. Johns Manville Corporation: www.jm.com/#sle.
   2. Jacket: Sheet material, off-white color.
      a. Minimum Service Temperature: Minus 40 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.02 perm inch, 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 equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

C. Exposed Equipment: 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 a domestic hot water system and exposed vertical storm risers).

D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated equipment containing fluids below ambient temperature: Insulate entire system.

G. Install cellular melamine with factory-applied jackets with a manufacturer-approved adhesive along seams, both straight lap joints and circumferential lap joints.
   1. Install seal over seams with factory-approved room temperature vulcanization (RTV) silicone sealant to ensure a positive vapor barrier seal in outdoor and sanitary wash down environments.

H. For fiberglass insulated equipment containing fluids below ambient temperature, provide vapor barrier jackets, factory-applied or field-applied, and finish with glass cloth and vapor barrier adhesive.

I. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

J. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

K. Fiberglass insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

L. Inserts and Shields:
   1. Application: Equipment 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between hangers and inserts.

3. Insert location: Between support shield and equipment 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.

M. Finish insulation at supports, protrusions, and interruptions.

N. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

O. Exterior Applications:
1. Provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement.
2. Cover with aluminum, stainless steel, or _____.

P. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

3.03 SCHEDULES

A. Plumbing Systems:
1. Domestic Hot Water Storage Tanks:
a. Glass Fiber, Flexible Insulation: 1 inches thick.
b. Glass Fiber, Rigid Insulation: 1 inches thick.

END OF SECTION 220716

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cellular glass insulation.

B. Cellular melamine insulation.

C. Flexible removable and reusable blanket insulation.

D. Glass fiber insulation.

E. Jacketing and accessories.

F. Supplies and drains for hand

G. Section includes insulating the following pipe systems
   1. Domestic Cold Water Piping
   2. Domestic Hot Water Piping
   3. Domestic recirculating hot water piping
   4. Roof Drains and Rainwater leaders

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, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2025.

E. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.

F. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2022.

G. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

H. ASTM C1410 - Standard Specification for Cellular Melamine Thermal and Sound-Absorbing Insulation; 2017 (Reapproved 2023).

I. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2025.

J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2025.

K. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

L. 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.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, 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.

1.07 COORDINATION

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

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

C. Coordinate installation and testing of heat tracing.

1.08 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 CELLULAR MELAMINE INSULATION

A. Manufacturers:
   1. TECHLITE: www.techlite.com/#sle.

B. Insulation: Flexible preformed open-cell polymeric foam tubing, slit lengthwise for installation, complying with applicable requirements of ASTM C1410.
   1. K Value: ASTM C177; 0.25 at 75 degrees F.
   2. Maximum Service Temperature: 350 degrees F.

2.03 GLASS FIBER INSULATION

A. Manufacturers:
   1. CertainTeed Corporation: www.certainteed.com/#sle.
   2. Johns Manville Corporation: www.jm.com/#sle.
   3. Knauf 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.

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.

2.04 CELLULAR GLASS INSULATION

A. Manufacturers:
1. Owens Corning Corporation; FOAMGLAS: www.ocbuildingspec.com/#sle.

B. Insulation: ASTM C552, Type II, Grade 6.
1. K Value: 0.35 at 100 degrees F.
2. Service Temperature Range: From 250 degrees F to 800 degrees F.
3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
4. Water Absorption: 0.5 percent by volume, maximum.

2.05 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. Install cellular melamine with factory-applied jackets with a manufacturer-approved adhesive along seams, both straight lap joints and circumferential lap joints.
1. Install seal over seams with factory-approved room temperature vulcanization (RTV) silicone sealant to ensure a positive vapor barrier seal in outdoor and sanitary washdown environments.

F. Glass fiber insulated pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

G. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

H. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.

3.03 INDOOR PIPING INSULATION SCHEDULE

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

B. **Domestic Hot and Recirculated Hot Water (105-140 F):**
   1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

C. **Stormwater and Overflow:**
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. **Roof Drain and Overflow Drain Bodies:**
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. **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.

F. **Sanitary Waste Piping Where Heat Tracing Is Installed:**
   1. All Pipe Sizes: Insulation shall be the following:
      a. Cellular Glass: 2 inches thick.

3.04 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

END OF SECTION 220719

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 beyond 5 feet of building.
K. Natural gas piping, buried within 5 feet of building.
L. Natural gas piping, above grade.
M. 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; 2021.
D. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.
E. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.
F. ASME B31.1 - Power Piping; 2024.
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; 2024.
I. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2025.
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; 2022.

M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

N. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2026.

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; 2026.

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; 2025.

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. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.

BB. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.

CC. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2023.

DD. AWWA C651 - Disinfecting Water Mains; 2023.

EE. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.

FF. 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.

GG. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

HH. NSF 372 - Drinking Water System Components - Lead Content; 2024.

II. 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 Institue (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 manufactuer 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, sovent.
   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, sovent.
   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, sovent.
   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, sovent.
   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, sovent.
   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, 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.

2.09 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.

2.10 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.

2.11 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.

2.12 NATURAL GAS PIPING, ABOVE GRADE

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

2.13 PIPE FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 inch and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.
   2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. No-Hub Couplings:
   1. Testing: In accordance with ASTM C1277 and CISPI 310.
   2. NSF Certification
   3. Gasket Material: Neoprene complying with ASTM C564.
   4. Band Material: Stainless steel.
   5. Eyelet Material: Stainless steel.
   6. Manufacturers:
      a. MIFAB, Inc; MI-QHUB: www.mifab.com/#sle.
      b. Charlotte Pipe and Foundry
      c. Ideal Tridon

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

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

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Install piping to maintain headroom, conserve space, and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 220516.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 083100.

H. Establish elevations of buried piping outside the building to ensure not less than 5 ft of cover for pipes that require freeze protection.

I. Install vent and gas piping penetrating roofed areas to maintain integrity of roof assembly and to comply with manufacturer warrenty.

J. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
   1. See Section 099113 for painting of exterior plumbing systems and components.

K. Excavate in accordance with Section 312316.

L. Backfill in accordance with Section 312323.

M. Install valves with stems upright or horizontal, not inverted. See Section 220523.

N. Install water piping to ASME B31.9.

O. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

P. Sleeve pipes passing through partitions, walls, and floors.

Q. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

R. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.
   8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

S. Pipe Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a watertight seal.
   6. Install in accordance with manufacturer's recommendations.

3.04 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

D. Provide spring-loaded check valves on discharge of water pumps.

3.05 FIELD TESTS AND INSPECTIONS

A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.

B. Test Sanitary waste and vent piping according to procedures of AHJ or in absense 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 seperate 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 then 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 biologival examination shows contaimination.
    e. Submit water sampes in sterile bottles to NYS Department of Health approved lab with results sent to the DOH and to the architect/engineer of record as project submittal.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water sample approval from NYS Department of Health approved lab.

C. Where new fixture have been added to nYS K-12 school buildings, test samples shall be taken at all new fixtures in accordance with SED testing protocol for Lead. Submit test results to Arch/Engineer./District.

3.08 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve, and sand strainer.
    1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

END OF SECTION 221005

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. Water hammer arrestors.
G. Mixing valves.
H. 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 1013 - Reduced Pressure Principle (RP) Backflow Prevention Assemblies; 2026.
E. ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems; 2023.
F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2023.
G. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
H. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
I. DIN 19580 - Drainage Channels for Vehicular and Pedestrian Areas - Durability, Mass Per Unit Area and Evaluation of Conformity; 2010.
J. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
K. NSF 372 - Drinking Water System Components - Lead Content; 2024.
L. 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 General Purpose:
   1. Assembly: ASME A112.6.4.
   2. Body: Lacquered cast iron with sump.
   3. Strainer: Removable cast aluminum 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: www.jrsmith.com/#sle. Equal to Figure 1015 Series
      b. Josam
      c. MIFAB, Inc; R1200 Large Sump Roof Drain: www.mifab.com/#sle.
      d. Zurn Industries, LLC; Z100F: www.zurn.com/#sle.
      e. Watts

B. Roof Drains (RD-2) Secondary Overflow (to daylight):
   1. Assembly: ASME A112.6.4.
   2. Body: Lacquered cast iron with sump.
   3. 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. Controlled flow weir. 2" high
      f. Adjustable extension sleeve for roof insulation.
   4. Manufacturers:
      a. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle. Equal to figure 1045
      b. Josam
      c. MIFAB, Inc; _____: www.mifab.com/#sle.
      d. Zurn Industries, LLC; Z100F: www.zurn.com/#sle.
      e. Watts

C. Downspout Nozzles - For Secondary RD daylight termination (DN-1):
   1. Stainless Steel with hinged cover and perforated flap
   2. Size to match associated RD-2

3. Equal to JR Smith Figure 1775

D. Floor Drains:
   1. Manufacturers:
      a. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
      b. Josam
      c. MIFAB, Inc: www.mifab.com/#sle.
      d. Zurn Industries, LLC: www.zurn.com/#sle.
      e. Watts

E. 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. Equal to JR Smith Figure 2051

F. 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.

G. Floor Sink FS-1:
   1. ASME A112.6.3; _____ stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and 10+" square stainless steel extra heavy duty strainer with 3/4 grate and removable sediment bucket.
   2. Set with cover flush to finished floor, in accessible location, but not in the normal path of travel.
   3. Equal to JR Smith Sani-Ceptor stainless steel Series 3001

H. Shower Channel Drain (SCD-1): Factory fabricated stainless steel channel and grate with built in outlet pipe.
   1. Plumbing Connector Type: Stainless steel.
   2. Channel Length: 55 inches.
   3. Grate Style: To be selected by Architect from manufacturer's full range.
   4. Material: Electropolished stainless steel.
   5. Outlet Pipe: 2 inch diameter.

I. Prefabricated Trench Drain (TD-1): For use in Garage - Trench drain system assembled from factory fabricated, polymer concrete castings in standard lengths and variable depths, with integral joint flanges and integral grating support rails; includes joint gaskets and grating.
   1. Equal to JR Smith Figure # 9879
   2. Load Class: DIN 19580, ClassF.
   3. Grating Material and Style: Slotted ductile iron grate and rail
   4. Trench Width: 12 inches.
   5. Trench Section Length: 39 inches and 19-1/2 inches.
   6. Grating Support Rail: Ductile Iron.
   7. Accessories:
      a. Foul air trap.
      b. Sediment trap - catch basin

J. Prefabricated Floor Trench TD-2:
   1. Equal to JR Smith Figure # 9931
   2. Body: Glass fiber reinforced polymer concrete cast in standard or custom assembly with integral aluminum load bearing frame and concrete anchors.

3. Body: Molded polyproylene, integra steel load bearing frame.
4. Section Width: 8 inches.
5. Section Length: As indicated on drawings with 0.5 percent slope.
6. Section Sealing: Polyester joint sealant.
7. Grate: Ductile iron, heel-proof paver slot for heavy traffic. Load class E.
8. Outlet: 4 inches at the bottom side.
9. Sediment Trap - Catch basin

2.03 CLEANOUTS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
2. Josam Company: www.josam.com/#sle.
3. MIFAB, Inc; C1100-R: www.mifab.com/#sle.
4. Zurn Industries, LLC: www.zurn.com/#sle.
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: www.jrsmith.com/#sle.
2. Zurn Industries, LLC: www.zurn.com/#sle.
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:
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: _____ inch assembly with threaded gate valves.

B. Reduced Pressure Backflow Preventer Assembly:
1. ASSE 1013 and NSF 61 compliant Lead Free Cast Iron 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, integral male test fittings, and non-threaded vent outlet.

2. Size: 3/4 to 2 inch assembly with threaded full port ball valves.
3. Size: 2-1/2" to 8" inch assembly with threaded gate valves.
4. Maximum Working Parameters: 175 psi at 180 degrees F.
5. Accessories: Provide lead-free Y-strainer and test cocks.

2.06 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.

2.07 MIXING VALVES

A. Thermostatic Master Mixing Valves:
   1. Manufacturers:
      a. Leonard Valve Company: www.leonardvalve.com/#sle.
      b. Watts Water Technologies; POWERS: www.watts.com/#sle. Equal to LFSH1432.
   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.

2.08 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. Corrdinate 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. 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.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. 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.

F. Pipe relief from backflow preventer to nearest drain.

G. 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 221006

SECTION 221114
FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

A. Section 083100 - ACCESS DOORS AND PANELS.

B. Section 099113 - Exterior Painting.

C. Section 220516 - Expansion Fittings and Loops for Plumbing Piping.

D. Section 312316 - Excavation.

E. Section 312323 - Fill.

F. Section 335216 - Gas Hydrocarbon Piping.

1.03 REFERENCE STANDARDS

A. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2019 (Reaffirmed 2024).

B. ANSI Z21.80/CSA 6.22 - Line Pressure Regulators; 2019 (Reaffirmed 2024).

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

D. ASME B31.1 - Power Piping; 2024.

E. ASME B31.9 - Building Services Piping; 2025.

F. 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; 2025, with Errata.

G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

H. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

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 D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2026.

K. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2020.

L. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.

M. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.04 SUBMITTALS

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

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.

D. Shop Drawings: For both penetrating and non-penetrating rooftop supports, submit detailed layout developed for this project from a 3rd party delegated designer, with design calculations for loadings, spacings and achor material specifications.

E. Warrenty documentation from Vendor.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

E. Identify pipe with marking including size, ASTM material classification, and ASTM specification.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

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

1.07 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11. HDPE, or as otherwise approved by the Gas Utility Company in the area of the project.
   1. Fittings: ASTM D2683 or ASTM D2513 socket type.
   2. Joints: Fusion welded.
   3. Provide with detectable warning tape as required by code and local Gas Utility company

2.02 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Transition from HDPE below grade to Steel pipe above grade, just outside building founation, with manufacturered anodless pipe riser

2.03 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.

2.04 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.

B. Flanges for Pipe Size Over 1 Inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

2.05 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. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
   4. Vertical Pipe Support: Steel riser clamp.

5. Rooftop Supports for Low-Slope Roofs: Steel pedestals with 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; and as follows:
   a. Bases: UV resistant High density polypropylene.
   b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
   d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
   e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
   f. Spacing min. 10' on center and within 2' of each elbow or Tee.
6. Rooftop Supports for Low-Slope Roofs, where it is shown by 3rd party delegated design that attachement/anchorige to roof/structure is required:
   a. Bases: UV resistant High density polypropylene.
   b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
   d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
   e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
   f. In addition, at least every other roof support (i.e. every 20' on center), provide anchorage to roof membrane and/or roof structure per delegated design. Coordinate with roof contractor/vendor to ensure all roof warrenties are maintained.

2.06 BALL VALVES

A. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded ends with union.

2.07 PLUG VALVES

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

2.08 GAS CONTROL VALVES (I.E. CLASS ROOM SCIENCE SHUT DOWN)

A. Equal to American Gas Safety (AGS) Merlin 1000S system incuding the following:
   1. UL61010 listed Controller
   2. Gas Leak Detectors, and pressure monitoring equipment
   3. Solenoid Valve, tied to control panel. One per classroom.
   4. Push button Emergency Stop Botton with key operated reset
   5. Automatic time of day controls (i.e. for automated night time shut off).
   6. Contacts for connection to building management system (BMS).

2.09 NATURAL GAS DETECTION EQUIPMENT

A. Equal to American Gas Safety (AGS) AGSNGiS Natural Gas Detector including the following components:
   1. Detector with on screen Natural Gas LEL% reading
   2. Audible Alarm Beacon
   3. Associated electrical transformer and wiring.
   4. Refer to drawings for locations.

2.10 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

A. Compliance Requirements:
   1. Appliance Regulator: ANSI Z21.18/CSA 6.3.
   2. Line Pressure Regulator: ANSI Z21.80/CSA 6.22.

B. Materials in Contact With Gas:
   1. Housing: Aluminum, steel (free of non-ferrous metals).
   2. Seals and Diaphragms: NBR-based rubber.

C. Maximum Inlet Operating Pressure: 10 psi.

D. Maximum Body Pressure: 10 psi.

E. Output Pressure Range: 7" inch wc to 80 inch wc.

F. Refer to gas schedule on plans for BTU/hr, Min and max gas pressure for each piece of equipment, and location of required regulators.

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 and State Fuel Gas Code.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide non-penetrating roof mounted pipe supports, at least every 10' and within 2' of every Elbow, Tee or regulator.

H. Anchor gas pipe to roof membrane every 20' at minimum, or as otherwise prescribed by 3rd party delegated designer to withstand wind loading, as required by Building code and ASCE 7. Achorage shall be coordinated with existing roof and associated warrenty.

I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

J. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors

K. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.

L. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; Consult existing roof vendor and Refer to existing roof warrenty.

M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

N. Provide support for utility meters in accordance with requirements of utility companies.

O. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
   1. Painting of exterior piping systems and components is specified in Section 099113.

P. Excavate in accordance with Section 312316.

Q. Backfill in accordance with Section 312323.

R. Install valves with stems upright or horizontal, not inverted.

S. Install seperate branch with valve to emergency generators, immediately downstream of Utility meter/regulator assembly and upstream of main building valve. Clearly label valve for service to generator.

T. Drip and sediment traps shall be provided upstream of each equipment connection, except in locations subject to freezing.

U. Provide Strainer upstream of each line-pressure regulator or electrically operated valve.

V. Provide pressure guage upstream and downstream of each line-pressure regulator.

W. Provide required pipe vents or vent limiting devices as required by manufacturer for each line-pressure regulator, and at all equipment gas trains.

X. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.

Y. Gas piping to be electrically continous and bonded according to NFPA 70.

Z. Sleeve pipes passing through partitions, walls and floors.

AA. Exterior gas piping shall be primed and painted. Refer to Architectural plans for color and paint specifications.

BB. Gas piping from Utility meter and regulator shall rise up outside of the building foundation, and enter the building above grade. Below grade penetrations into the building are not allowed.

CC. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   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. Use hangers with 1-1/2 inch 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. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.04 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install ball for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Provide plug valves in natural gas systems for shut-off service.

3.05 SERVICE CONNECTIONS

A. Provide new gas service complete with gas meter and regulators in accordance with Section 335216. Gas service distribution piping to have initial minimum pressure of 7 inch wg. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

B. Coordinate new service with Local Utilitiy Company. Contractor responsible for communication with Utilitiy company related to project schedule and date for service to be turned on.

END OF SECTION 221114

SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Floor drains.

B. Floor sinks.

C. Cleanouts.

1.02 SUBMITTALS

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

B. Product Data: Provide manufacturer's literature and data sheets for each product. Include information on fabrication materials, assembly of components, dimensions, ratings, finishes, rough-in requirements, and installed accessories.

C. Shop Drawings:
   1. Floor sinks: Provide drawings overlaid on latest published kitchen equipment plans showing dimensioned locations of floor sinks.

D. Manufacturer's Instructions: Provide for products listed below. Include instructions for handling, protection, examination, preparation, and installation.

1.03 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for packaging waste requirements.

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

C. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

D. Store products under cover and protected from weather and dirt. Elevate above grade.

E. Store plastic products protected from direct sunlight.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Plastic Sanitary Waste Piping Specialties: Provide plastic products that comply with NSF 14.

B. Source Limitations: Furnish drains and sanitary waste piping specialties of same kind by same manufacturer.

2.02 FLOOR DRAINS

A. Cast Iron Floor Drains:
   1. Manufacturers:
      a. Jones Stephens: www.jonesstephens.com/#sle.
      b. Zurn Water, LLC: www.zurn.com/#sle.
   2. Assembly: ASME A112.6.3.
   3. Body: Lacquered cast iron with anchor flange and membrane clamping collar with weepholes.
   4. Strainer: Adjustable, removable, with vandal-proof screws.

B. Cast Iron Area Drains:
   1. Manufacturers:
      a. MIFAB, Inc: www.mifab.com/#sle.
   2. Assembly: ASME A112.6.3.

3. Body: Lacquered cast iron with anchor flange with weepholes and membrane clamping collar.
4. Grate: Ductile or cast iron, complying with ADA Standards, loose set in top frame.

END OF SECTION 221319

SECTION 221323
SANITARY WASTE INTERCEPTORS

PART 2 PRODUCTS

1.01 GENERAL REQUIREMENTS

A. Source Limitations: Furnish interceptors of same kind by same manufacturer.

END OF SECTION 221323

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SECTION 221423
STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof and exterior surface drains.

B. Downspout adaptors, boots, and nozzles.

C. Trench drains.

D. Cleanouts.

E. Backwater valves.

1.02 SUBMITTALS

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

B. Product Data: Provide manufacturer's literature and data sheets for each product. Include information on fabrication materials, assembly of components, dimensions, ratings, finishes, rough-in requirements, and installed accessories.

C. Shop Drawings:
   1. Provide dimensioned plans showing locations of drains for the following:

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Plastic Storm Drainage Piping Specialties: Provide plastic products complying with NSF 14.

B. Source Limitations: Furnish drains and storm drainage piping specialties of same kind by same manufacturer.

2.02 ROOF AND EXTERIOR SURFACE DRAINS

A. Cast Iron Roof Drains and Overflow Roof Drains:
   1. Manufacturers:
      a. MIFAB, Inc: www.mifab.com/#sle.
      b. Zurn Water, LLC: www.zurn.com/#sle.
   2. Assembly: ASME A112.6.4.
   3. Body: Lacquered cast iron with membrane clamping ring with gravel stop.
   4. Strainer: Removable thermoplastic polymer dome with vandal-proof screws.

2.03 DOWNSPOUT ADAPTERS, BOOTS, AND NOZZLES

A. Downspout Adapters:
   1. Description: Lacquered cast iron transition fitting to connect parapet drain to exterior rainwater downspout.

B. Downspout Nozzles, Metal:
   1. Description: Cast bronze or nickel bronze wall-mounted fitting for terminating interior rainwater leader on building exterior, with anchor flange and decorative cow's tongue outlet.

2.04 CLEANOUTS

A. Manufacturers:

B. Floor Cleanouts:
   1. Assembly: ASME A112.36.2.
   2. Body: Lacquered cast iron.
   3. Closure Plug: PVC or ABS, threaded, gastight and watertight.

4. Top: Adjustable, with vandal-proof screws.

C. Wall Cleanouts:
1. Assembly: ASME A112.36.2.
2. Body: Tee type; body material to match surrounding pipe.
3. Plug: PVC or ABS, threaded, gastight.
4. Access Cover: Round, stainless steel wall access cover with vandal-proof screw.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

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

B. Maintain continuity of waterproofing membranes. Secure waterproofing membranes to drain clamping collars.

C. Install roof drains at low points of roof areas.

D. Extend cleanouts to finished floor or wall surface. Ensure clearance at cleanout for rodding or jetting of drainage system.

E. Install floor cleanouts to allow for floor finishes.

F. Locate, provide, and install cleanouts in piping in accordance with adopted code.

3.03 CLEANING

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

B. Clean debris from drains.

C. Clean grates and strainers prior to mm-dd-yyyy.

3.04 PROTECTION

A. Protect installed drains from accumulating dirt and debris through remainder of construction.

B. Protect installed products from damage due to subsequent construction operations.

END OF SECTION 221423

SECTION 221429
SUMP PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pedestal sump pumps.

B. Submersible sump pumps.

C. 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 PEDESTAL SUMP PUMPS

A. Manufacturers:
   1. PROFLO: www.ferguson.com/#sle.
   2. Superior Pump: www.superiorpump.com/#sle.
   3. Zoeller Pump Company: www.zoellerpumps.com/#sle.

B. Materials: Heavy-duty thermoplastic pump column housing and base with noncorrosive stainless steel shaft and impeller.

C. Motor: Top mount, enclosed, lubricated oil-free, thermal-overload protected, continuous duty, permanent split capacitor with oil-resistant, three-prong connector, 10 foot power cord.

D. Controls: Chemically resistant, shaft-supported, steel-rod mount, adjustable vertical float switch.

E. Discharge Port Size: 1-1/4 inch, NPT, female.

2.02 SUBMERSIBLE SUMP PUMPS - REFER TO SCHEDULE ON PLANS

A. Manufacturers:
   1. Grundfos Pumps Corporation; _____: www.grundfos.com/#sle.
   2. Liberty Pumps
   3. PROFLO: www.ferguson.com/#sle.
   4. Superior Pump: www.superiorpump.com/#sle.
   5. Zoeller Company: www.zoeller.com/#sle.

B. General: Rugged stainless steel and 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. Controls: Integral, chemically-resistant, vertical plated-steel rod float switch. Cycle pump Off/On between 2.5 and 9 inch heights from bottom of pump.

F. Solids Handling Capacity: Pass lint and other small solids up to 1/2 inch in size.

G. Discharge Pipe Size: 2 inch, NPT, female.

H. Maximum Water-Based Effluent Temperature: 120 degrees F.

I. Accessories: Provide full flow swing-type discharge check valve.

2.03 SUBMERSIBLE ELEVATOR SUMP PUMPS - REFER TO SCHEDULE ON PLANS

A. Manufacturers:
   1. Grundfos Pumps Corporation: www.grundfos.com/#sle.
   2. Liberty Pumps - equal to ELV-series with OilTector
   3. Stancor
   4. PROFLO: www.ferguson.com/#sle.
   5. Superior Pump: www.superiorpump.com/#sle.
   6. Zoeller Company: www.zoeller.com/#sle.

B. Performance:
   1. Flow: 50 gpm, at 14 feet head.
   2. Motor: 1/2 hp, 120 VAC , single phase, 60 Hz.
   3. 50 gpm required for each elevator car, per ASME A17.1 Elevator Code

C. General: Cast iron housing and base with oil-filled motor chamber, ball bearings, and mechanical seal.

D. Impeller: Thermoplastic; open nonclog, stainless steel shaft.

E. 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.

F. 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.

G. Solids Handling Capacity: Pass lint and other small solids up to 1/2 inch in size.

H. Discharge Pipe Size: 1-1/2 inch, NPT, female.

I. Accessories: Provide full flow swing-type discharge check valve.

J. Minimum sump pit size: 18"dia x 36" deep

2.04 SUMP BASINS AND PITS - REFER TO SCHEDULE ON PLANS

A. Sump Basin:

1. Manufacturers:
   a. Plumbstar USA: www.plumbstarusa.com/#sle.
   b. Topp Industries, Inc: www.toppindustries.com/#sle.
   c. Zoeller Company: www.zoeller.com/#sle.
2. Basin Volume Holding Capacity: ___ gal.
3. Below Ground Pipe Inlet: Molded or predrilled with seal, 4 inch.
4. Basin Dimensions: 30 inch diameter, 36 inch deep.
5. Basin Material: Polyethylene, heavy duty injection molded.
6. Molded-Finish Requirements: Hard bottom, watertight, gas-tight and radon-tight molding.
7. Maximum Effluent Temperature: Match or exceed maximum pump service temperature.
8. Basin Riser Extension: Diameter matched, 6 inch with hardware.
9. 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.

B. Sump Pit:
1. Ground-dug, stone-surface lined hole with minimum of 4 inch gravel base.
2. Pit Construction: 20 gal capacity, 4 inch below ground pipe inlet.
3. Pit Opening Diameter and Height: 18 by 30 inch, add lining thickness.
4. Maximum Effluent Temperature: Match or exceed maximum pump service temperature.
5. Pit Cover:
   a. Manufacturers:
      1) Plumbstar USA: www.plumbstarusa.com/#sle.
      2) Topp Industries, Inc: www.toppindustries.com/#sle.
      3) Zoeller Company: www.zoeller.com/#sle.
   b. Material: One-piece flat lid made of polyethylene with seal gasket.

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 221429

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SECTION 223000
PLUMBING 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. Commercial gas-fired water heaters.

B. Mixing Valves.

C. Balance Valves.

D. Diaphragm-type compression tanks.

E. In-line circulator pumps.

F. Pressure booster systems.

G. Electrical Equipment Disconnect

1.03 RELATED REQUIREMENTS

1.04 REFERENCE STANDARDS

A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.

B. ANSI Z21.10.1 - Gas Water Heaters, Volume I, Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less; 2019 (Reaffirmed 2024).

C. ANSI Z21.10.3 - Gas-Fired Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous; 2019 (Reaffirmed 2024).

D. 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.

E. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .

F. ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

1.05 SUBMITTALS

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

B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Provide electrical characteristics and connection requirements, including any required disconnects.

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

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

E. Project Record Documents: Record actual locations of components.

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.

B. Certifications:
   1. Water Heaters: NSF 61 approved.
   2. Indirect-Fired Gas Water Heaters: AHRI Directory of Certified Product Performance.
   3. Water Tanks: ASME labeled to ASME BPVC-VIII-1.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.08 WARRANTY

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Systems: Provide plumbing equipment that complies with NSF 61 and NSF 372 for maximum lead content, as applicable with Federal and State regulations.

2.02 WATER HEATERS (WH-1, WH-2)

A. Water Heater:

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but not limited to, the following:
   1. A.O. Smith Water Products Co: www.hotwater.com/#sle. **Equal to BTH-120 (A)**
   2. Bock Water Heaters, Inc: www.bockwaterheaters.com/#sle.
   3. Bradford White Corporation: www.bradfordwhite.com/#sle.
   4. Rheem Manufacturing Company: www.rheem.com/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

C. Commercial Gas-Fired Water Heaters:
   1. Type: Automatic, natural gas-fired, vertical storage.
   2. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
   3. Performance:
      a. Energy Factor: 95.
      b. Storage Capacity: 60 gal.
      c. Input: 120,000 Btuh _____.
      d. Minimum Recovery Rate: 138 gph with 100 degrees F temperature rise.
      e. Maximum Working Pressure: 150 psig.
   4. Tank: Antimicrobial-infused, enamel-lined, welded steel, ASME labeled; multiple flue passages, 4-inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
   5. Accessories:
      a. Water Connections: Brass.
      b. Dip Tube: Brass.
      c. Drain valve.
      d. Anode: Magnesium.
   6. Applications:
   7. Controls: Automatic water thermostat with temperature range adjustable from 120 to 180 degrees F, automatic reset high temperature limiting thermostat factory set at 195 degrees F, gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood.

2.03 MIXING VALVES (MV-1)

A. Thermostatic Master Tempering Valves:
   1. Manufacturers: Subject to compliance requirements, available manufacturers offering products that my be incorporated into the work include, but are not limited to, the following:
      a. Leonard Valve Company; _____: www.leonardvalve.com/#sle.
      b. Powers, A Watts Brand. **Equal to LFSH1432**
      c. Powers, A Watts Brand. **Equal to LFSH1434**
      d. Lawler Valve Co.
      e. Substitutions: See Section 016000 - Product Requirements.
   2. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
   3. Capacity: 38 gpm at 20 psi differential.
   4. Capacity: 85 gpm at 20 psi differential.
   5. Low flow 1 gpm
   6. Accessories:
      a. Shut off & Check valve on inlets.
      b. Volume control shut-off valve on outlet.
      c. Stem thermometer on outlet.
      d. Strainer stop checks on inlets.

2.04 BALANCE VALVES

A. Balance Valves
   1. Manufacturers: Subject to compliance requirements, available manufacturers offering products that may be incorpoprated into the work include, but are not limited to, the following:
   2. Tacotherm Ltd: www.tacotherm.co.uk.
   3. Bell & Gossett. **Equal to A549LFP**
   4. **Nibco. Equal to 1810 Series**
   5. Circuit Setter
   6. Substitutions: See Section 016000 - Product Requirements.

B. Body: Lead-Free Brass.

C. Ball: 304 Stainless Steel.

D. Seat Rings: Glass and Carbon filled TFE.

E. Readout Valves: Brass with EPT check valves.

F. Stem "O" Ring: EPDM.

2.05 DIAPHRAGM-TYPE COMPRESSION TANKS (ET-1)

A. Expansion Tanks:

B. Manufacturers: Subject to compliance requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Amtrol Inc: www.amtrol.com/#sle. **Equal to ST-5C-DD**
   2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
   3. Taco, Inc: www.taco-hvac.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

C. 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 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

D. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig.

2.06 IN-LINE CIRCULATOR PUMPS (RP-1)

A. Recirculation Pumps:

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Armstrong Fluid Technology: www.armstrongfluidtechnology.com/#sle.
   2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
   3. PACO Pumps; Grudfos Pump Corporation, USA_____. **Equal to UP1555SFC**
   4. Substitutions: See Section 016000 - Product Requirements.

C. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.

D. Impeller: Bronze.

E. Controller: Honeywell Aquastat model **L4006A2007-U**

F. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.

G. Seal: Carbon rotating against a stationary ceramic seat.

H. Drive: Flexible coupling.

I. Performance:
   1. Flow: 3 gpm, at 12 feet head.

2.07 PRESSURE BOOSTER SYSTEMS

A. Manufacturers:
   1. Armstrong Fluid Technology; _____: www.armstrongfluidtechnology.com/#sle.
   2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
   3. Grudfos

B. System: Packaged with two pumps, factory assembled, tested, and adjusted; shipped to site as integral unit; consisting of pumps, valves, and galvanized piping, with control panel mounted on fabricated steel base with structural steel framework.

C. Controls and Instruments: Locate in NEMA EN 10250 Type 1 general-purpose enclosure with main disconnect interlocked with door, fused circuit for each motor, magnetic starters with three overloads, control-circuit transformer with fuse protection, selector switch for each pump, low limit pressure switch, low-pressure alarm light, running lights, current-sensing devices, minimum-run timers, manual alternation, and suction and discharge pressure gauges.

D. Lead Pump: Operate continuously with lag pump running on system demand. If lead pump fails to function, next pump in sequence to start automatically.

E. Time-Delay Relay: Prevent lag pump short cycling on fluctuating demands.

F. Thermal Bleed Circuit with Solenoid Valve: Prevent overheating during low demand.

G. Low-Pressure Control: Stop pump operation if incoming water pressure drops to atmospheric.

H. Pump Switch: Permit manual or automatic operation.

I. Valving: Provide each pump outlet with combination pressure reducing and check valve to maintain constant system pressure. Provide gate or butterfly valves on suction and discharge of each pump. Provide check valve on each pump discharge.

J. Time Clock for Automatic Day-Night Changeover:
   1. Day Cycle: Operate system continuously with pressure to fixtures maintained by pressure-reducing valves.
   2. Night Cycle: Operate pump intermittently on pressure switch located near pressure tank operating pump for predetermined adjustable time period.

2.08 SUBMERSIBLE SUMP PUMPS

A. Manufacturers:
   1. Armstrong Fluid Technology: www.armstrongfluidtechnology.com/#sle.

2. Goulds Water Technology, a xylem brand: www.goulds.com/#sle.
3. Zoeller Company: www.zoeller.com/#sle.
4. Liberty

B. Type: Completely submersible, vertical, centrifugal.

C. Casing: Cast iron pump body and oil filled motor chamber.

D. Impeller: Cast iron; open non-clog, stainless steel shaft.

E. Bearings: Ball bearings.

F. Sump: Fiberglass basin with steel cover plate; ____ inches diameter, ____ inches deep.

G. Accessories: Oil resistant 6 foot cord and plug with three-prong connector for connection to electric wiring system including grounding connector.

H. Servicing: Slide-away coupling consisting of discharge elbow secure to sump floor, movable bracket, guide pipe system, lifting chain and chain hooks.

I. Controls: Motor control panel containing across-the-line electric motor starters with ambient compensated quick trip overloads in each phase with manual trip button and reset button, circuit breaker, control transformer, electro mechanical alternator, hand-off-automatic selector switches, pilot lights, high water alarm pilot light, reset button and alarm horn. Provide mercury switch liquid level controls, steel shell switch encased in polyurethane foam with cast iron weight for pump on (each pump), pump off (common), and alarm.

J. Performance:
1. Flow: _____ gpm, at _____ feet lift.
2. Motor: ____ hp, ____ volt, single phase, 60 Hz.

2.09 ELECTRICAL WORK

A. Provide electrical motor driven equipment specified complete with motors, motor starters, controls, disconnects and wiring.

B. Disconnect shall be rated and sized for the associated piece of equipment. Coordinate with electrical contract for power connection.

C. Electrical characteristics to be as specified or indicated.

D. Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.

E. Supply manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices not shown.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions required for applicable certifications.

B. Balance domestic water circulation systems so that there is a minimum 0.5-1 gpm through each branch with a balance valve. For small existing circulation pumps, flow through each branch should be roughly total pump flow divided by total number of circulated branches.

C. Domestic Water Storage Tanks:
1. Provide steel pipe support, independent of building structural framing members.
2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

D. Pumps:
1. Ensure pumps 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.

END OF SECTION 223000

SECTION 224000
PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flush valve water closets.

B. Wall hung urinals.

C. Wall-hung, solid surface, multistation lavatory units.

D. Wall-hung, multistation wash fountains.

E. All-in-one lavatory system.

F. Sinks.

G. Under-lavatory pipe supply covers.

H. Shower receptors.

I. Bi-level, electric water coolers with bottle filler

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 A112.19.1 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures; 2024.

H. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2024.

I. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.

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; 2025, with Addendum

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

1. Provide Plumbing Fixtures and all accessories as indicated on the plumbing fixture schedule on the drawings. Acceptable manufacturer are indicated below.
   a. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
   b. Delany Products; _____: www.delanyproducts.com/#sle.

c. DXV by American Standard, Inc; _____: www.dxv.com/#sle.
d. Sloan Valve Company; _____: www.sloanvalve.com/#sle.
e. Kohler Company; _____: www.kohler.com/#sle.
f. Viega LLC; _____: www.viega.us/#sle.
g. Zurn Industries, Inc; _____: www.zurn.com/#sle.
h. _____.
i. Substitutions: See Section 016000 - Product Requirements.

2.04 FLUSH VALVE WATER CLOSETS (WC-1)

A. Water Closets: Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action.
1. Bowl: ASME A112.19.2; 15 Inches high with elongated rim.
2. Flush Valve: Exposed (top spud).
3. Flush Operation: Sensor operated.
4. Handle Height: 44 inches or less.
5. Trapway Outlet: 4 inch.
6. Color: White.

B. Basis of Design _____

C. Flush Valves:

D. See Plumbing Schedule for Model Information

E. Toilet Seats:
1. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.

F. See Plumbing Schedule for Model Information

G. 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 FLUSH VALVE WATER CLOSETS - ADA (WC-2)

A. Water Closets: Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action.
1. Bowl: ASME A112.19.2; 16.5 inches high with elongated rim.
2. Flush Valve: Exposed (top spud).
3. Flush Operation: Sensor operated.
4. Handle Height: 44 inches or less.
5. Supply Size: 1-1/2 inches.
6. Outlet Size: 4 inches.
7. Color: White.

B. See Plumbing Schedule for Model Information

C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
1. Sensor-Operated Type: Solenoid or motor-driven operator, low voltage hard-wired, infrared sensor with mechanical over-ride or over-ride push button.
2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.

D. See Plumbing Schedule for Model Information

E. Seats:
1. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.
2. See Plumbing Schedule for Model Information

F. Water Closet Carriers:

1. Manufacturers:
   a. Jay R. Smith MFG. Co; _____: www.jrsmith.com/#sle.
   b. JOSAM Company; _____: www.josam.com/#sle.
   c. Zurn Industries, Inc; _____: www.zurn.com/#sle.
   d. _____.
   e. Substitutions: See Section 016000 - Product Requirements.
2. 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.

2.06 TANK TYPE WATER CLOSETS (WC-1)

A. Bowl: ASME A112.19.2; floor mounted, siphon jet, vitreous china, 15 inches inches high, close-coupled closet combination with elongated rim, insulated vitreous china closet tank with fittings and lever flushing valve, bolt caps.
   1. Water Consumption: Maximum 1.28 gallons per flush.

B. Basis of Design _____

C. See Plumbing Schedule for Model Information

D. Water Closet Carrier:

2.07 TANK TYPE WATER CLOSETS - ADA (WC-2)

A. Bowl: ASME A112.19.2; floor mounted, siphon jet, vitreous china, 16.5 inches inches high, close-coupled closet combination with elongated rim, insulated vitreous china closet tank with fittings and lever flushing valve, bolt caps.
   1. Water Consumption: Maximum 1.28 gallons per flush.

B. Basis of Design _____

C. Seat: Solid white plastic, open front, extended back, less cover, complete with self-sustaining hinge.

D. See Plumbing Schedule for Model Information

E. Water Closet Carrier:
   1. Manufacturers:
      a. Jay R. Smith MFG. Co; _____: www.jrsmith.com/#sle.
      b. JOSAM Company; _____: www.josam.com/#sle.
      c. Zurn Industries, Inc; _____: www.zurn.com/#sle.
      d. Viega LLC; _____: www.viega.us/#sle.
      e. _____.
      f. Substitutions: See Section 016000 - Product Requirements.
   2. 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.

2.08 WALL HUNG URINALS (UR-1)

A. Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
   1. Flush Volume: 0.5 gallons, maximum.
   2. Flush Valve: Exposed (top spud).
   3. Flush Operation: Sensor operated.
   4. Trapway Outlet: Integral.
   5. Basis of Design _____

B. Flush Valves:
   1. Sensor-Operated Type: Solenoind or motor-driven operator, low voltage hard-wired, infrared sensor with mechanical over-ride or over-ride push button.
   2. See Plumbing Schedule for Model Information

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.

2.09 WALL HUNG URINALS - ADA (UR-2)

A. Urinals: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
   1. Flush Volume: 0.5 gallons, maximum.
   2. Flush Style: Washout.
   3. Flush Valve: Exposed (top spud).
   4. Flush Operation: Sensor operated.
   5. Trap: Integral.
   6. Removable stainless steel strainer.
   7. Supply Size: 3/4 inch.
   8. Outlet Size: 2 inches.

B. See Plumbing Schedule for Model Information

C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
   1. Sensor-Operated Type: Solenoind or motor-driven operator, low voltage hard-wired, infrared sensor with mechanical over-ride or over-ride push button.

D. 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.

2.10 LAVATORIES (LAV-1)

A. Wall-Hung Basin:
   1. Vitreous China: ASME A112.19.2; white, rectangular basin with splash lip, front overflow, soap depression, and hanger. Size as indicated on drawings with 4-inch centerset spacing.
   2. Carrier:
      a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, bearing plate and studs.

B. See Plumbing Schedule for Model Information

C. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
   1. Spout Style: Standard.
   2. Mixing Valve: _____.
      a. Provide ASSE 1070 mixing valve for Tempered water to all Public Lavatories.
   3. Water Supply: 3/8 inch compression connections.
   4. Aerator: Vandal resistant, 0.5 gpm, laminar flow device.
   5. Automatic Shut-off: 30 seconds.
   6. Finish: Polished chrome.
   7. Lead Content: Extra low; maximum 0.25 percent by weighed average.

D. Thermostatic Mixing Valve:
   1. ASSE 1070 listed with combination stop, strainer, and check valves, and flexible stainless steel connectors.

E. See Plumbing Schedule for Model Information

F. Accessories:
   1. Chrome-plated 17 gauge, 0.0538 inch brass P-trap with clean-out plug and arm with escutcheon.

2.11 LAVATORIES - ADA (LAV-2)

A. Vitreous China Under-Mount Basin: ASME A112.19.2; vitreous china under-mount lavatory, front overflow, mounting kit and template by manufacturer.

B. See Plumbing Schedule for Model Information

C. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
   1. Spout Style: Standard.
   2. Power Supply: Battery, easily replaceable, alkaline or lithium, minimum 200,000 cycles.
   3. Low battery indicator warning light at 30 days remaining life and continuous light a 2 weeks.

D. Power Supply: Per manufacturer's requirements.
   1. Cord and plug.
   2. For 6V or 24V applications, provide transformer.

E. Mixing Valve: Internal, automatic.

F. Water Supply: 3/8 inch compression connections.

G. Aerator: Vandal resistant, 0.5 GPM, laminar flow device.

H. Sensor range: Factory set at a minimum of 3 inch adjustable up to 24 inch.

I. Finish: Polished chrome.

J. Accessory: 4 inch deck plate.

K. Lead Content: Extra low; maximum 0.25 percent by weighed average.

L. Thermostatic Mixing Valve: Thermostatic mixing valve, ASSE 1070 listed, with combination stop, strainer, and check valves, and flexible stainless steel connectors.

M. See Plumbing Schedule for Model Information

N. Provide lavatory with combination stop and strainer.

O. Accessories:

P. Chrome plated 17 gauge, 0.0538 inch brass P-trap with clean-out plug and arm with escutcheon.

Q. Offset waste with perforated open strainer.

R. Wheel handle stops.

S. Flexible supplies.

T. Carrier:
   1. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, bearing plate and studs.

2.12

2.13 SINKS (SK-1)

A. See Plumbing Schedule for Model Information

B. Faucet: ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.

2.14 SINKS - ADA (SK-2) SINGLE BOWL

A. Substitutions: See Section 016000 - Product Requirements.

B. See Plumbing Schedule for Model Information

C. Single Compartment Bowl: ; _____ by _____ by _____ inch outside dimensions 20 gauge, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
   1. Drain: 1-1/2 inch chromed brass drain.
   2. Drain: 3-1/2 inch crumb cup and tailpiece.

D. Faucet: ASME A112.18.1; chrome plated combination supply fitting with open grid strainer, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.

E. Substitutions: See Section 016000 - Product Requirements.

2.15 SINKS - (SK-3) DOUBLE BOWL

A. See Plumbing Schedule for Model Information

B. Double Compartment Bowl: ; _____ by _____ by _____ inch outside dimensions 20 gauge, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

C. Drain: 1-1/2 inch chromed brass drain.

D. Drain: 3-1/2 inch crumb cup and tailpiece.

E. Faucet: ASME A112.18.1; chrome plated combination supply fitting with open grid strainer, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.

2.16 SINKS - ADA (SK-4) DOUBLE BOWL

A. See Plumbing Schedule for Model Information

B. Double Compartment Bowl: ; _____ by _____ by _____ inch outside dimensions 20 gauge, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

C. Drain: 1-1/2 inch chromed brass drain.

D. Drain: 3-1/2 inch crumb cup and tailpiece.

E. Faucet: ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.

F.

2.17 UNDER-LAVATORY PIPE SUPPLY COVERS

A. Manufacturers:
   1. Plumberex Specialty Products, Inc; _____: www.plumberex.com/#sle.
   2. Truebro
   3. Oatey
   4. _____.
   5. Substitutions: See Section 016000 - Product Requirements.

B. General:
   1. Insulate exposed drainage piping, as well as, hot, cold and tempered water supplies under lavatories or sinks per ADA Standards.
   2. Construction: 1/8 inch PVC with antimicrobial, antifungal and UV resistant properties.
      a. Comply with ASME A112.18.9 for covers on accessible lavatory piping.
      b. Comply with ICC A117.1.
   3. Color: High gloss white.
   4. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces. No cable ties allowed.

2.18 SHOWERS (SH-1)

2.19 ELECTRIC WATER COOLERS (EWC-1)

A. Manufacturers:
   1. Elkay Manufacturing Company; _____: www.elkay.com/#sle.
   2. Haws Corporation; _____: www.hawsco.com/#sle.
   3. Oasis International; _____: www.oasiscoolers.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. See Plumbing Schedule for Model Information

C. Water Cooler: 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.

2.20 BI-LEVEL, ELECTRIC WATER COOLERS WITH BOTTLE FILLER - ADA (EWC-2)

A. Manufacturers:
   1. Elkay Manufacturing Company; _____: www.elkay.com/#sle. Equal to LZSTL8WSLK
   2. Haws Corporation; _____: www.hawsco.com/#sle.
   3. Oasis International; _____: www.oasiscoolers.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

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, NSF 42 and 53. 3000 gallon capacity and filter status indicator LED.
   3. Provide with Bottle filling station with usage counter.
   4. Electrical: 115 VAC, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

2.21 MOP SINKS (MR-1)

A. See Plumbing Schedule for Model Information

B. Terrazzo Mop Sink Manufacturers:
   1. Acorn Engineering Company; _____: www.acorneng.com/#sle.
   2. Fiat Products; equal to TSB-100
   3. Just Manufacturing Company; _____: www.justmfg.com/#sle.
   4. Zurn Industries, LLC; _____: www.zurn.com/#sle.

C. Material: Precast terrazzo composed of marble chips cast in Portland cement.

D. Type: Rectilinear, standard height, 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.

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.

B. Review Architectural elevations and coordinate installation of fixtures with accessories provided by other trades such as mirrors, access panels, ADA grab bars, lighting, etc.

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 224000

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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. Hand-held emergency drench hose.

G. Safety stations (combination emergency fixture units).

H. Emergency-fixture water-tempering valves.

1.02 REFERENCE STANDARDS

A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2014, with Editorial Revision (2020).

B. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011 (Reaffirmed 2017).

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 SELF-CONTAINED EYEWASH EQUIPMENT

A. See Plumbing Schedule for Model Information

B. ANSI Z358.1, 15 gallon, pressurized portable eyewash vessel-station assembly.

C. Valve: Full flow, self-close, quick to open using fitted wide-handle manual hand operator.

D. Signage: ANSI Z535.2, emergency eyewash safety equipment, tank affixed.

2.04 PERSONAL EYEWASH EQUIPMENT

A. See Plumbing Schedule for Model Information

B. Wall-mounted, emergency labeled eye wash station with one-16 oz bottled fluid saline solution.

C. Portable emergency labeled eye wash travel pack with six-4 oz and six-1 oz bottled fluid saline solution.

2.05 EYE/FACE WASH EQUIPMENT

A. ANSI Z358.1, wall-mounted bowl with dual eye-spray head assembly.

B. Pipe and Fittings Material: PVC.

C. Valve: Full flow, self closing, quick to open thru wide-handle manual hand operator.

D. Drain: Built-into the bowl assembly with 1-1/4 inch female outlet.

2.06 HAND-HELD EMERGENCY DRENCH HOSE

A. ANSI Z358.1, 15 gallon drench hose with flanged spray head assembly.

B. Hose:
1. 8 feet long, flexible reinforced PVC with fitted male swivel water connection.
2. Maximum Working Pressure: 275 psi.

C. Handle: Full flow, self closing, quick to open plastic covered metal lever handle.

2.07 SAFETY STATIONS (COMBINATION EMERGENCY FIXTURE UNITS)

A. Pipe and Fittings Material: Powder coated galvanized steel.

B. 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.

C. 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.

2.08 EMERGENCY-FIXTURE WATER-TEMPERING VALVES

A. Tepid Water Temperature: Set to 85 degrees F.

B. Capacity: Sized for 5 gpm at 30 psi supply pressure.

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 224500

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SECTION 230000
GENERAL PROVISIONS FOR MECHANICAL WORK

ACCESSAAPART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Requirements of this Section apply to work in every Section of Division 23 equally as if incorporated therein.

1.02 WORK INCLUDED

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

1.03 SCOPE

A. Division of the Specification into sections is for the purpose of simplification alone. Responsibility for the work of various trades shall rest with the Contractor. Various sections of this Division are related to each other as well as the mechanical drawings. Examine all drawings and read all applicable parts of the project manual in order to ensure complete execution of all work in this Division, coordinating where required with other trades in order to avoid conflicts.

B. These specifications and accompanying drawings are intended to cover the furnishing of all labor, materials, equipment and services necessary for the complete installation and acceptable performance of the mechanical systems. Small items of material, equipment and appurtenances not mentioned in detail or shown on the drawings, but necessary for complete and operating systems shall be provided by this contractor without additional charge to the Owner and shall be included under this contract.

C. In general, specifications establish the quality of material, equipment and workmanship. The contract documents are intended to secure for the Owner, a first-class installation in every respect. Labor shall be performed by skilled mechanics, and the entire facility, when delivered to the Owner, shall be ready for satisfactory and efficient operation.

D. The Contractor shall carefully examine the drawings and specifications before accepting the contract. He shall call attention to any changes or additions which, in his opinion, are necessary to make possible the fulfillment of any guarantee called for by these specifications; failing which, it shall be deemed that he has accepted full responsibility for all such guarantees.

E. The contractor shall put his work in place as fast as is reasonably possible. He shall, at all times, keep a competent foreman in charge of the work, to make decisions necessary for the diligent advancement of the work. The Contractor shall facilitate the inspection of the work by the Owner's Representative.

F. The Contractor shall coordinate all work in the building in order to facilitate intelligent execution of the work. He shall also remove any rubbish as expeditiously as possible.

G. Materials or products specified herein and/or indicated on the drawings by trade’s names, manufacturer's names, model number or catalog numbers establish the quality of materials or products to be furnished. Model numbers are to be confirmed by the manufacturer to provide required capacities and material to meet the specifications and design intent. In no instance shall an obsolete, incomplete or inaccurate trade name, manufacturer name, model number or catalog number indicated on the drawings, result in additional charges to the owner.

H. Points of connection or continuation of work under this contract are so marked on drawings or herein specified. In case of any doubt as to the required exact location of such points, the Owner's Representative shall decide and direct.

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

1.04 REFERENCE STANDARDS, CODES AND REGULATIONS

A. Requirements of Regulatory Agencies:
   1. Nothing contained in these specifications or shown on the drawings shall be construed to conflict with any State or local laws, ordinances, rules and regulations, the UL and NFPA regulations. The Contractor shall make all changes required by the enforcing authorities. Where alterations to and / or deviations from the Contract Documents are required by the authorities having jurisdiction, report the requirements to the Engineer and secure acceptance before work is started. All such changes shall be made in a manner acceptable to the Engineer and shall be made without cost to the Owner.
   2. When drawings or specifications exceed requirements of applicable laws, ordinances, rules and regulations, comply with documents establishing the more stringent requirement. All work shall be done in full conformity with the requirements of all authorities having jurisdiction. Installation shall be made in compliance with all applicable regulations, and utility company rules, all of which shall be considered a part of this specification and shall take precedence in the order of listing.
   3. It is not the intent of drawings or specifications to repeat requirements of codes except where necessary for completeness in individual sections.

B. Published specifications, standards, tests or recommended method of trade, industry or governmental organizations as listed below apply to all work in this Division, in addition to other standards which may be specified in individual sections:
   1. Associated Air Balance Council
   2. Air Diffuser Balance Council
   3. Air Moving and Conditioning Association
   4. American Gas Association
   5. American National Standards Institute
   6. Air Conditioning and Refrigeration Institute
   7. American Society of Heating, Refrigeration and Air Conditioning Engineers
   8. American Society of Mechanical Engineers
   9. American Society for Testing and Materials
   10. Cast Iron Soil Pipe Institute
   11. ETL Testing Laboratories
   12. Factory Mutual Engineering and Research Corporation
   13. National Standard Plumbing Code
   14. National Electrical Manufacturer's Association
   15. National Fire Protection Association
   16. National Board of Fire Underwriters
   17. National Electric Code
   18. Occupational Safety and Health Administration
   19. Plumbing Drainage Institute
   20. Sheet Metal & Air Conditioning Contractors National Association
   21. Underwriters Laboratories, Inc.

C. Furnish and file with the proper authorities, all drawings required by them in connection with the work. Contractor shall secure and obtain all approvals, permits, licenses and inspections and pay all legal and proper fees and charges in this connection, before commencing work in order

to avoid delays during construction. He shall deliver the official records of the granting of the permits, etc., to the Owner's Representative.

1.05 QUALITY ASSURANCE

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

B. Supply all equipment and accessories new and free from defects.

C. Supply all equipment and accessories in compliance with the applicable standards listed in Article 1.4 of this section with all applicable national, state and local codes.

D. All items of a given type shall be the product of same manufacturer.

1.06 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.
   3. Words or phrases such as "The Contractor shall", "shall be", "furnish", "provide", "a", "an", "the", and "all" may have been omitted for brevity.

B. Drawings: Mechanical drawings under this contract are made a part of these specifications. Deviations from these specifications as noted below must have the approval of the Engineer or Construction Manager without an increase in contract price.
   1. The drawings shall be considered as being diagrammatic and for bidding purposes only. Intention is to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement. The attention of the contractor is called to the fact that while these drawings are generally to scale and are made as accurately as the scale will permit, all critical dimensions shall be determined in the field. They are not to be considered as erection drawings.
   2. The drawings do not indicate every fitting, elbow, offset, valve, etc. which is required to complete the job. Contractor shall prepare field erection drawings as required for the use of his mechanics to insure proper installation.
   3. Scaled and figured dimensions are approximate and are for estimating purposes only. Indicated dimensions are limiting dimensions.
   4. Before proceeding with work check and verify all dimensions in field.
   5. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
   6. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
   7. For exact locations of building elements, refer to dimensional Architectural/Structural drawings.

C. Description of systems: Provide all materials to provide functioning systems in compliance with performance requirements specified, and any modifications resulting from reviewed shop drawings and field coordinated drawings.
   1. Installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawings.

D. Do not use equipment exceeding dimensions indicated or equipment or arrangements that reduce required clearances or exceed specified maximum dimensions.

E. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect for his interpretation and decision as early as possible, including during bidding period.
   1. Do not proceed with work without Engineer's decision.

1.07 EQUIPMENT MANUFACTURERS

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

B. The contractor is required to verify that equipment and material to be used on the project meets the requirements of the specifications and will physically fit the available space, clearance and service requirements of the particular piece of equipment and include all pertinent information when he submits material for acceptance. Contractor shall also be responsible for and bear the cost of any modifications to openings available or anticipated as being available for rigging equipment to its final installation place. This shall include openings in exterior envelope, walls and roofs, interior walls, corridors, passage ways or door openings. Any on site dismantling and any reassembly of equipment made necessary by impediment to the rigging of said equipment shall be the sole responsibility of the contractor.

C. Contract document indicates power and physical requirements based on the equipment manufacturer's data as first named. If equipment requiring more system capacity is furnished, the contractor shall be responsible for the cost associated with modifying the design and installation of associated services, including any redesign costs associated with the engineer’s review.

1.08 DEFINITIONS

A. "Provide": To supply, furnish, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.

B. "Install": To erect, mount and connect complete with related accessories.

C. "Supply", "Furnish": To purchase, procure, acquire and deliver complete with related accessories.

D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

E. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

F. "Wiring": Raceway, fittings, wire, boxes and related items.

G. "Concealed": Items referred to as hidden from normal sight, embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.

H. "Exposed": Not installed underground or "concealed" as defined above.

I. "Indicated", "Shown", or "Noted": As indicated, shown or noted on drawings or specifications.

J. "Directed": Directed by Engineer.

K. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified product.

L. "Reviewed", "Satisfactory", or "Directed": As reviewed, satisfactory, or directed by or to Engineer.

M. "Motor Controllers": Manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.

N. "Control or Actuating Devices": Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

O. "Remove": Dismantle, demolish and take away from the site and dispose of in accordance with all applicable rules and regulations or, should the Owner so require, deliver to a location as designated by the Owner for the use of the Owner, at no additional cons to the Owner.

P. "Replace": Remove existing and provide an equivalent product or material as specified.

Q. "Extract (and Reinstall) ": Carefully disassemble, dismantle existing, save or store where directed by the Owner, in such a manner as to preserve the existing condition and reinstall as indicated on the drawings or as described in the specifications.

R. Where any device or piece of equipment is referred to in the singular number, such reference shall be deemed to apply to as many devices as are required to complete the installation.

1.09 JOB CONDITIONS

A. This contractor shall investigate all conditions affecting his work and shall provide such offsets, fittings, valves, sheet metal work, etc., as may be required to meet conditions at the building.

B. The contractor shall verify all measurements at the building site and shall be responsible for the correctness of same before ordering materials or before starting work of any Section.
   1. Report to Architect, in writing, conditions which will prevent proper provision of this work.
   2. Beginning work of any Section without reporting unsuitable conditions to Architect constitutes acceptance of conditions by Contractor.
   3. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.

C. Piping and ductwork shall be concealed or run behind furring in finished spaces unless otherwise noted to be run exposed.

D. Horizontal piping and ductwork not run below slabs on grade shall be run as close as possible to underside of roof or floor slab above and parallel to building lines. Maintain maximum headroom in all areas.

E. Determine possible interference between trades before the work is fabricated or installed. The contractor must coordinate his work to insure that erection will proceed without such interference. Coordination is of paramount importance and no request for additional payment will be considered where such request is based upon interference between trades.

F. Connections to Existing Work:
   1. Install new work and connect to existing work with minimum of interference to existing facilities.
   2. Temporary shutdowns of existing services:
   3. At no additional charges
      a. At times not to interfere with normal operation of existing facilities.
      b. Only with written consent of Owner.
   4. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
   5. Restore existing disturbed work to original condition.

G. Removal, extraction and relocation of existing work.
   1. The work includes demolition or removal of all construction indicated or specified. All materials resulting from demolition work, except as indicated or specified otherwise, shall become the property of the Contractor and shall be removed from the site. Rubbish and debris shall be removed from the site daily unless otherwise directed so as to not allow accumulation inside or outside the building. Materials that cannot be removed daily shall be stored in areas specified by the Owner.
   2. Title to all materials and equipment to be demolished, excepting Owner salvage and historical items, is vested in the Contractor upon receipt of notice to proceed. The Owner will not be responsible for the condition, loss or damage to such property after notice to proceed.
   3. The Owner reserves the "Right of First Refusal" on all material for salvage. Material for salvage shall be stored as approved by the Owner. Salvage materials shall be removed from the site before completion of the Contract. Material for salvage shall not be sold on the site.

4. Property of the Owner: Salvaged items remaining the property of the Owner shall be removed in a manner to prevent damage and packed or crated to protect the items from damage while in storage or during shipment and relocated by the contractor at no cost, to the Owners designated storage facility on the site. Containers shall be properly identified as to contents.
5. Damaged Items: Items damaged during removal or storage shall be repaired or replaced to match existing.
6. Disconnect, remove or relocate material, equipment, plumbing fixtures, piping and other work noted and required by removal or changes in existing conditions.
7. Where existing pipes, conduits and/or ducts which are to remain prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits, and/or ducts.
8. Provide new material and equipment required for relocated equipment.
9. Plug or cap active piping or ductwork behind or below finish.
10. Do not leave long dead-end branches.
    a. Cap or plug as close as possible to active line.
11. Remove unused piping, ductwork and equipment.
12. Dispose of unusable piping, ductwork and material.

1.10 CLEARANCE FROM ELECTRICAL EQUIPMENT

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

1.11 TEMPORARY FACILITIES

A. Temporary facilities are not included within this Section.

1.12 SPECIAL TOOLS

A. Furnish to Owner at completion of work:
1. One set of any special tools required to operate, adjust, dismantle or repair equipment furnished under any section of the Division.
2. "Special tools": those not normally found in possession of mechanics or maintenance personnel.
3. One pressure grease gun for each type of grease required.

a. With adapters to fit all lubricating fittings on equipment.
b. Include lubricant for lubricated plug valves.

1.13 PRODUCT DELIVERY, HANDING AND STORAGE

A. Provide adequate and secure storage facilities for materials and equipment during the progress of the work.

B. Contractor shall be responsible for the condition of all materials and equipment employed in the mechanical installation until final acceptance by the Owner. Protect same from any cause whatsoever.

C. Where necessary, ship in crated sections of size to permit passing through available space.

D. Ship equipment in original packages, to prevent damaging or entrance of foreign matter.

E. Handle and ship in accordance with manufacturer's recommendations.

F. Provide protective coverings during construction.

G. Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by Engineer.

H. Tag all items with weatherproof tag, identifying equipment by name and purchase order number.

I. Include packing and shipping lists.

J. Adhere to special requirements as specified in individual sections.

1.14 PROTECTION OF MATERIALS

A. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed.

B. Provide temporary storage facilities for materials and equipment.

C. Material, equipment or apparatus damaged because of improper storage or protection will be rejected.
1. Remove from site and provide new, duplicate, material, equipment, or apparatus in replacement of that rejected.

D. Cover motors and other moving machinery to protect from dirt and water during construction. Rotate moving equipment, shafts, bearings, motors etc. to prevent corrosion and to circulate lubricants.

E. Protect premises and work of other Divisions from damage arising out of installation of work of this Division.
1. Contractor shall be responsible for the replacement of all damaged or defective work, materials or equipment. Do not install sensitive or delicate equipment until major construction work is completed.
2. Remove replaced parts from premises.

F. Make good any damage to the work caused by floods, storms, accidents, acts of God, acts of negligence, strikes, violence or theft up to time of final acceptance by the Owner.

G. Do not leave any mechanical work in a hazardous condition, even temporarily.

1.15 REVIEW OF CONSTRUCTION

A. Work may be reviewed at any time by representative of the Engineer.

B. Advise Architect and Engineer that work is ready for review at following times:
1. Prior to backfilling buried work.
2. Prior to concealment of work in walls and above ceilings.
3. When all requirements of Contract have been completed.

C. Neither backfill nor conceal work without Engineer's consent.

D. Maintain on job a set of Specifications and Drawings for use by Engineer's representatives.

1.16 SCHEDULE OF WORK

A. Arrange work to conform to schedule of construction established or required to comply with Contract Documents.

B. In scheduling, anticipate means of installing equipment through available openings in structure.

C. Confirm in writing to Architect and Engineer, within 30 days of signing of contract, anticipated number of days required to perform test, balance, and acceptance testing of mechanical systems.
   1. This phase must occur after completion of mechanical systems, including all control calibration and adjustment, and requires substantial completion of the building, including closure, ceilings, lighting, partitioning, etc.
   2. Submit for approval at this time, names and qualifications of test and balancing agencies to be used.

D. Arrange with Owner schedule for work in each area.

E. Unless otherwise directed by Owner, perform work during normal working hours.

F. Work delays:
   1. In case noisy work interferes with Owner's operations, Owner may require work to be stopped and performed at some other time, or after normal working hours.

1.17 ACCESS TO MECHANICAL WORK

A. Access doors in walls and ceilings.

B. Access Units Fire-Resistance Ratings: Where fire-resistance rating is indicated for construction penetrated by access units, provide UL listed-and-labeled units, except for units which are smaller than minimum size requiring ratings as recognized by governing authority.

C. Product Data, Access Units: Submit manufacturer's technical data and installation instructions for each type of access door assembly, including setting drawings, templates, instructions and directions for installation of anchorage devices.

D. Furnish to the general contractor all access doors necessary for access through inaccessible wall or ceiling construction, for installation by the general contractor. Information on the size and location of the subject access doors is to be communicated in writing to the general contractors during the bidding period.

1.18 CONCRETE FOR MECHANICAL WORK

A. Concrete for Mechanical Work
   1. Basins and curbs for mechanical equipment.
   2. Mechanical equipment foundations and housekeeping pads.
   3. Inertia bases for isolation of mechanical work.
   4. Rough grouting in and around mechanical work.
   5. Patching concrete cut to accommodate mechanical work.

B. Quality control testing for concrete is required as work of this section.

C. Concrete Work Codes and Standards:
   1. Comply with governing regulations and, where not otherwise indicated, comply with the following industry standards; whichever is the most stringent in its application to work in each instance.
      a. ACI 301: "Specifications for Structural Concrete for Buildings"
      b. ACI 311: "Recommended Practice for Concrete Inspection"
      c. ACI 318: "Building Code Requirements for Reinforced Concrete"

d. ACI 347R: "Recommended Practice for Concrete Form work"
e. ACI 304R: "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete"
f. Concrete Reinforcing Steel Institute's, "Manual of Standard Practice"

D. Submittals: Shop Drawings, Mechanical Concrete Work: Submit shop drawings for structural type concrete work, showing dimensions of formed shapes of concrete; bending, placement, sizes and spacing of reinforcing steel; location of anchors, isolation units, hangers and similar devices to be integrated with concrete work; and piping penetrations, access openings, inlets and other accessories and work to be accommodated by concrete work.

E. Laboratory Test Reports, Mechanical Concrete Work: Submit laboratory test reports for concrete work materials, and for tested samples of placed concrete (where required as work of this section).

1.19 NOISE REDUCTION

A. Cooperate in reducing objectionable noise or vibration caused by mechanical systems.
1. To extent of adjustments to specified and installed equipment and appurtenances.

B. Correct noise problems caused by failure to install work in accordance with Contract Documents.
1. Include labor and materials required as result of such failure.

1.20 CUTTING AND PATCHING

A. Provide all carpentry, cutting and patching required for proper installation of material and equipment specified.

B. Do not cut or drill structural members without consent of Architect.

1.21 COORDINATION DRAWINGS

A. Layout Shop Drawings Required:
1. Prepare layout shop drawings for all areas; minimum 3/8 inch scale.
2. Individual coordinated trade layout drawings are to be prepared for all areas.
3. General Contractor is to assure that each trade has coordinated work with other trades, prior to submittal where submittal is required.
a. Include stamp on each submittal indicating that layout shop drawing has been coordinated.
4. No layout shop drawing will be reviewed without stamped and signed coordinated assurance by General Contractor.
5. All changes shall be clearly marked on each submitted layout drawing.
6. Drawings shall show work of all trades including but not limited to'
a. Ductwork.
b. Piping: All Trades.
c. Mechanical Equipment.
d. Electrical Equipment.
e. Main Electrical conduits and bus ducts.
f. Equipment supports and suspension devices.
g. Structural and architectural constraints.
h. Show location of:
1) Valves
2) Piping specialties
3) Dampers
4) Access Doors
5) Control and electrical panels
6) Disconnect switches

7. Drawings shall indicate coordination with work in other Divisions that must be incorporated in mechanical spaces, including, but not limited to:
   a. Elevator equipment.
   b. Cable trays not furnished under Division 16.
   c. Computer equipment.
8. Submission of drawings:
   a. Prepare reproducible drawings.
   b. Submit to other trades for review of space allocated to all trades.
   c. Revise drawings to compensate for requirements of existing conditions and conditions created by other trades.
   d. Review revisions and other trades.
   e. Submit one reproducible and one blueline print to Engineer for review.
9. Final prepared drawings shall show that other trades affected have made reviews and signed, by each trade, at completions of coordination.
   a. General Contractor
   b. Include stamp on each submittal indicating that layout shop drawing has been coordinated.
10. No layout shop drawing will be reviewed without stamped and signed coordination assurance by General Contractor.

B. Shop Drawings:
1. Layout drawings of mechanical equipment rooms and penthouses showing all related equipment and equipment clearances required by other trades.
2. Layout drawings of areas in which it may be necessary to deviate substantially from layout shown on the drawings. Minor transitions in ductwork, if required due to job conditions, need not be submitted as long as the duct area is maintained. Show major relocation of ductwork and major changes in size of ducts. Coordinate shop drawings with all trades prior to ductwork fabrication.
3. Details of intermediate structural steel members required to span main structural steel for the support of ductwork.
4. Method of attachment of duct hangers to building construction.
5. Duct material, gage, type of joints and duct reinforcing for each size range, including sketches or SMACNA plate numbers for joints, method of fabrication and reinforcing.

1.22 GUARANTEE

A. Furnish guarantee covering all work in accordance with general requirements of the contract for minimum period of one year. This guarantee shall exist for a period of one (1) year from the date of final acceptance of the work and shall apply to defects in materials and to defective workmanship of any kind.

B. For factory-assembled equipment and devices on which the manufacturers furnish standard published guarantees as regular trade practice, obtain such guarantees and replace any such equipment that proves defective during the life of these guarantees.

C. Guarantee all work for which materials are furnished, fabricated or field erected by the contractor, all factory-assembled equipment for which no specific manufacturer's guarantee is furnished, and all work in connection with installing manufacturer's guarantee is furnished, and all work in connection with installing manufacturer's guaranteed equipment.

D. In the event of failure of any work, equipment or device during the life of the guarantee, repair or replace the equipment or defective work. Remove, replace or restore, at no cost to the Owner, any part of the structure or building which may be damaged either as the direct result of the defective work or in the course of the contractor's making replacement of the defective work or materials. Work shall be done at a time and in a manner as to cause no undue

inconvenience to the Owner. Provide new materials, equipment, apparatus and labor to replace that determined by Engineer to be defective or faulty.

E. This guarantee also applies to services including Instructions, Adjusting, Testing, Noise, Balancing, etc.

F. Additional equipment and material guarantees and warrantees may be indicated in other sections. In all cases, the more stringent guarantee or warrantee shall be provided.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT QUALITY

A. Material and equipment furnished under this Division of specification shall be new. Defective or inferior materials must be replaced by contractor at no cost to Owner regardless of the stage of construction. Inferior material shall be defined as material or equipment of a quality or performance less than that specified as determined by the Owner's Representative.

B. Provide each item of equipment with manufacturer's identification tag which is readily accessible and clearly shows model and size.

2.02 ACCESS TO MECHANICAL WORK

A. Access Doors:
   1. General: Where walls and ceilings must be penetrated for access to mechanical work, access doors shall be provided. Furnish adequate size for intended and necessary access. Furnish doors with UL Fire Rating to match wall or ceiling construction. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.

B. Access Door Construction: Refer to Section 083113 – ACCESS DOORS AND FRAMES

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Tests:
   1. Perform as specified in individual sections, and as required by authorities having jurisdiction.
   2. Duration as noted.

B. Provide required labor, material, equipment, and connections.

C. Furnish written report and certification those tests have been satisfactorily completed.

D. Repair or replace defective work, as directed.

E. Pay for restoring or replacing damaged work due to tests as directed.

F. Pay for restoring or replacing damaged work of others, due to tests, as directed.

3.02 ACCESS TO MECHANICAL WORK

A. Coordinate installation and placement of access doors and panels with contractor for general construction.

B. Remove or replace panels or frames that are warped, bowed, or otherwise damaged.

END OF SECTION 230000

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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. Local Control Devices: Where indicated, furnish standard duty push buttons or 3-position hand-off-auto selector switch mounted in the controller enclosure.

F. 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. Square D Co. Class 2510, Type M (or Class 2510, Type F - single phase, 1 HP or less only).
   4. Cutler-Hammer. B100 (or MS - single phase, 1 HP or less only).

B. Type A2 (2 Speed, 2 Winding, Full Voltage, Manual, Non-Magnetic):
   1. Allen-Bradley Co. Bulletin 609TS (or Bulletin 600 - single phase, 1 HP or less only).
   2. General Electric Co. CR-1062 (or CR-101 - single phase, 1 HP or less only).
   3. Square D Co. Class 2512, Type M (or Class 2512, Type F - single phase, 1 HP or less only).

C. Type B (Full Voltage Magnetic):
   1. Allen-Bradley Co. Bulletin 709.
   2. General Electric Co. CR-206.
   3. Square D Co. Class 8536.
   4. Cutler-Hammer. ECN05.

D. Type B-COM (Combination Full Voltage Magnetic/Safety Switch):
   1. Allen-Bradley Co. Bulletin 712.
   2. General Electric Co. CR-208.
   3. Square D Co. Class 8538.
   4. Cutler-Hammer. ECN16.

E. Type B2 (2 Speed, 2 Winding, Full Voltage, Magnetic):
   1. Allen-Bradley Co. Bulletin 715.
   2. General Electric Co. CR209.
   3. Square D Co. Class 8810.
   4. Cutler-Hammer. ECN33.

F. Type C (Automatic, Reduced Voltage, Magnetic):
   1. Allen-Bradley Co. Bulletin 746.
   2. General Electric Co. CR-231.
   3. Square D Co. Class 8606.
   4. Cutler-Hammer. ECA42.

G. Type C-COM (Combination Automatic, Reduced Voltage, Magnetic/ Safety Switch):
   1. Allen-Bradley Co. Bulletin 746C.
   2. Square D Co. Class 8606.
   3. Cutler-Hammer. ECA43.

H. Type D (Part Winding, Magnetic):
   1. Allen-Bradley Co. Bulletin 736.
   2. General Electric Co. CR-230.
   3. Square D Co. Class 8640.
   4. Cutler-Hammer. ECA45.

2.04 REMOTE PUSH BUTTON STATIONS

A. Start-Stop with pilot light in NEMA 1 enclosure unless otherwise indicated.
   1. Allen-Bradley Co. Bulletin 800S.
   2. General Electric Co. CR-2943.

3. Square D Co. Class 9001.
4. Cutler-Hammer. Class 10250.

2.05 SAFETY SWITCHES

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

2.06 NAMEPLATES

A. Phenolic Type: Standard phenolic nameplates with 3/8" minimum size lettering engraved thereon.

B. Embossed Aluminum: Standard stamped or embossed aluminum tags: Tech Products, Inc., Seton Name Plate Corp.

2.07 EMERGENCY PUSHBUTTON OPERATOR STATION

A. Acceptable Manufacturer: Square D or equal.

B. Switch Style: Class 9001, NEMA 4 rated emergency mushroom head pushbutton.

C. Voltage: 120VAC, 60Hz as required.

D. Contacts: 20A, 2-NO/2-NC contact.

E. Operation: Manual.

F. Normal position: Operator out.

G. Activated position: Operator in.

H. Reset: Manual, turn to release.

I. Enclosure: NEMA 4.

2.08 CUSTOM LEGEND PLATE

A. "EMERGENCY BOILER SHUTOFF"

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 230002

SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.02 RELATED REQUIREMENTS

A. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

B. Section 262913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015, with Errata (2026).

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.

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 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. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

C. 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.

D. 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. DX Fan Coil Unit:
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the DX fan coil unit and/or specified sequence of operation.
         3) Shaft Extension: Single.
      c. 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.
      d. Power Roof Ventilator (PRV):
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
         3) Shaft Extension: Single.

e. Energy Recovery Ventilator:
   1) Operating Mode: Constant cfm.
   2) Input: Motor manufacturer to coordinate control requirements with the control board of the energy recovery ventilator and/or specified sequence of operation.
   3) Shaft Extension: Single.
f. Hydronic Pump:
   1) Operating Mode: Constant speed.
   2) Input: Motor manufacturer to coordinate control requirements with the control board of the hydronic pump and/or specified sequence of operation.
   3) Flange Configuration: "C".

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 230513

SECTION 230516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flexible pipe connectors.

B. Expansion joints and compensators.

C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS

A. Section 232113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

A. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.

B. EJMA (STDS) - EJMA Standards; Eleventh Edition.

1.04 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES 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. Delegated-Design Submittal:
   1. General: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
   3. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   4. Alignment Guide Details: Detail field assembly and attachment to building structure.
   5. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

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.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

A. General:
   1. Flexible hose connectors shall be manufactured complete with section of corrugated metal house, compatible braid, with inlet and outlet connections as required.
   2. Flexible hose connectors shall be capable of compensating for lateral movement and vibration.
   3. Flexible hose connectors shall be manufactured complete with section of corrugated metal house, compatible braid, with inlet and outlet connections as required.
   4. For flammable liquid or gas service up to 4”, flexible hose connector shall be CSA / AGA certified.

B. Manufacturers:
   1. Flex-Weld, Inc: www.kelcoind.com/#sle.
   2. FNW: www.fnw.com/#sle.
   3. The Metraflex Company; _____: www.metraflex.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

C. Inner Hose: Stainless Steel.

D. Exterior Sleeve: Single braided, stainless steel.

E. Pressure Rating: 125 psi up to 12 inch.

F. Maximum Service Temperature: 450 degrees F.

G. End Connections: As specified for pipe joints.

H. Size: Use pipe sized units.

I. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. General:
   1. Flexible hose connectors shall be manufactured complete with section of corrugated metal house, compatible braid, with inlet and outlet connections as required.
   2. Flexible hose connectors shall be capable of compensating for lateral movement and vibration.
   3. Flexible hose connectors shall be manufactured complete with section of corrugated metal house, compatible braid, with inlet and outlet connections as required.
   4. For flammable liquid or gas service up to 4”, flexible hose connector shall be CSA / AGA certified.

B. Manufacturers:
   1. FNW: www.fnw.com/#sle.
   2. Flex-Weld, Inc: www.kelcoind.com/#sle.
   3. The Metraflex Company; _____: www.metraflex.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

C. Inner Hose: Bronze.

D. Exterior Sleeve: Braided bronze.

E. Pressure Rating: 125 psi up to 2 inch.

F. Maximum Service Temperature: 450 degrees F.

G. End Connections: As specified for pipe joints.

H. Size: Use pipe sized units.

I. Maximum offset: 3/4 inch on each side of installed center line.

J. Application: Copper piping.

2.03 EXPANSION JOINTS AND LOOPS - FLEXIBLE HOSE

A. General:
   1. Provide flexible hose expansion loop(s) as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction, or seismic movement of the piping system.
   2. Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal house, compatible braid, 180º return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.
   3. Flexible loops shall be capable of movement in the ±X, ±Y, and ±Z planes.

4. Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.
5. For flammable liquid or gas service up to 4", flexible expansion loops shall be CSA / AGA certified.
6. All flexible hose expansion loops shall be manufactured in accordance with the documented manufacturers weld procedure specifications in accordance with ASME Section IX.
7. All flexible hose expansion loops shall be manufactured in accordance with ASME / ANSI B31.1.

B. Manufacturers:
1. The Metraflex Company; Metraloop: www.metraflex.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

C. Corrugated Hose: Type 321 stainless steel.

D. Braid: 304 Stainless Steel braid shall be used for any series 300 stainless steel hose.

E. Fittings Materials of construction:
1. Carbon steel
   a. Standard weight / Sch 40 ASTM A 234 WPB
   b. Extra heavy / Sch 80 ASTM A 234 WPB
2. Stainless steel
   a. Sch 10 S Type 304 Stainless in accordance with ASTM A240
   b. Sch 40 S Type 304 Stainless in accordance with ASTM A240
   c. Sch 10 S Type 316 Stainless in accordance with ASTM A240
   d. Sch 40 S Type 316 Stainless in accordance with ASTM A240
3. End fittings shall match fittings material.
   a. Weld end in accordance with ASME B16.9
   b. MPT in accordance with ASME B1.20.1
   c. Plate flange with 150 lb. drilling.
   d. Raised Face Slip on Flange in accordance with ASME B16.5
   e. Weld neck flanges in accordance with ASME B16.5
   f. Grooved ends in accordance with ANSI C-606

F. Flexible hose expansion loops shall have a factory supplied; hanger / support lug located at the bottom of the 180º return.

G. Flexible hose expansion loop(s) shall be furnished with a plugged FPT to be used for a drain or air release vent.

H. Flexible hose expansion loop(s) shall be rated with an operating pressure in accordance with manufacturer's documentation. The operating pressure shall be based on burst pressure with a 4 to 1 safety factor.

2.04 ACCESSORIES

A. Pipe Alignment Guides:
1. Manufacturers:
   a. The Metraflex Company; PGQ Glide Riser Guide: www.metraflex.com/#sle.
   b. Substitutions: See Section 016000 - Product Requirements.
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. Engineered Riser Anchor Clamps:
1. Manufacturers:
   a. The Metraflex Company; Engineered Riser Anchor Clamp: www.metraflex.com/#sle.

b. Substitutions: See Section 016000 - Product Requirements.

2. Applications:
   a. Provide one clamp to serve as a riser clip.
      1) Verify the total load of filled pipe to be supported will be a safety factor of one less than the maximum loading of the clamp per the manufacturer's instructions.
   b. Provide one clamp above and one clamp below the slab to anchor pipe.
      1) Coordinate with the structural engineer to determine the maximum thrust loading calculated for the slab or floor structure. Use the maximum thrust loading calculations to verify the clamps will be a safety factor of one less than the maximum loading of clamp per the manufacturer's instructions.
3. Provide two piece, ductile iron in compliance with ASTM A536. Use with metal pipes with an outer diameter of 2.5 inches to 8 inches.

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 indicated.

END OF SECTION 230516

SECTION 230517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe sleeves.

B. Pipe-sleeve seals.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 230523 - General-Duty Valves for HVAC Piping-CPL.

C. Section 230553 - Identification for HVAC Piping and Equipment-CPL: Piping identification.

D. Section 230716 - HVAC Equipment Insulation-CPL.

E. Section 230719 - HVAC Piping Insulation-CPL.

1.03 REFERENCE STANDARDS

A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.

B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.

1.04 SUBMITTALS

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

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

A. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.
   3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
   4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

B. Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.

C. Pipe Passing Through 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.

D. 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.

E. Pipe Passing Through Mechanical, Laundry, and Animal 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.

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 in compliance with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

2.02 PIPE-SLEEVE SEALS

A. Modular Mechanical Sleeve-Seal:
1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
3. Size and select seal component materials in accordance with service requirements.
4. Glass-reinforced plastic pressure end plates.

B. Sealing Compounds:
1. Provide packing and sealing compound to fill pipe to sleeve thickness.
2. Combined packing and seal compound is to match partition fire-resistance hourly rating.

C. Pipe Sleeve Material:
1. Bearing Walls: Steel, cast iron, or terra-cotta pipe.
2. Masonry Structures: Sheet metal or fiber.

D. Wall Sleeve: PVC material with waterstop collar, and nailer end-caps.

E. Sleeve-Forming Disk: Non-conductive plastic-based material, 3 inch thick.

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. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
2. 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.
3. 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.
4. 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 230517

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SECTION 230519
METERS AND GAUGES FOR HVAC PIPING-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flow meters.

B. Electromagnetic flow meters.

C. Pressure gauges and pressure gauge taps.

D. Thermometers and thermometer wells.

E. Filter gauges.

1.02 RELATED REQUIREMENTS

A. Section 232113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).

D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

E. 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.

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 VENTURI FLOWMETERS

A. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.

B. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

C. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
   1. Design: Differential-pressure-type measurement for water.
   2. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
   3. Minimum Pressure Rating: 250 psig.
   4. Minimum Temperature Rating: 250 deg F.
   5. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
   6. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
   7. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

D. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
   1. Scale: Gallons per minute.
   2. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

E. Display: Shows rate of flow.

F. Conversion Chart: Flow rate data compatible with sensor.

G. Operating Instructions: Include complete instructions with each flowmeter.

2.02 ELECTROMAGNETIC FLOW METERS

A. Inline Type: Class 150 flanged with hard rubber liner, 1 inch.

B. Insertion Type: Include ball valve and threadolet.

C. Liquid Flow Capacity Range: As indicated on drawings.

D. Construction: Sensor with integral NEMA EN 10250 Type 4 or 4X stainless steel or aluminum enclosure to hold thermal mass sensor and circuits with numeric display for consumption reading.
   1. Electrode: Stainless steel.

E. Liquid Conductivity: 5 mS/cm, minimum.

F. Accuracy: Within 0.2 percent of value applied to manufacturer-specified velocity range.

G. Output: Two-wire, 0 to 10 VDC, non-loop powered.

H. Service Pressure and Temperature: Up to 400 psi and 15 to 250 degrees F liquid side, 150 degrees F ambient.

2.03 PRESSURE GAUGES

A. Manufacturers:
   1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
   2. Moeller Instrument Company, Inc; _____: www.moellerinstrument.com/#sle.
   3. Omega Engineering, Inc; _____: www.omega.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Steel with brass bourdon tube.
   2. Size: 4-1/2 inch diameter.
   3. Mid-Scale Accuracy: One percent.
   4. Scale: Psi.

2.04 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.

2.05 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
   2. Omega Engineering, Inc; _____: www.omega.com/#sle.
   3. Weksler Glass Thermometer Corp; _____: www.wekslerglass.com/#sle.

4. Substitutions: See Section 016000 - Product Requirements.

B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   3. Stem: 3/4 inch NPT brass.
   4. Accuracy: 2 percent, per ASTM E77.
   5. Calibration: Degrees F.

2.06 THERMOWELLS

A. Standard: ASME B40.200.

B. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.

C. Material for Use with Copper Tubing: Brass.

D. Material for Use with Steel Piping: 316 Stainless Steel.

E. Type: Stepped shank unless straight or tapered shank is indicated.

F. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.

G. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.

H. Bore: Diameter required to match thermometer bulb or stem.

I. Insertion Length: Length required to match thermometer bulb or stem.

J. Lagging Extension: Include on thermowells for insulated piping and tubing.

K. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.07 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.

2.08 TEST PLUGS

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

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

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

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

D. Install thermowells with extension on insulated piping.

E. Fill thermowells with heat-transfer medium.

F. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge with needle valves for isolation suction and discharge pressure.

G. 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.

H. Install pressure gauges on the inlet and outlet piping of all hydronic zones, hydronic coils, and heat transfer equipment.

I. Install pressure gauges upsteam and downstream of all pressure reducing valves.

J. 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.

K. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.

L. Inlet and outlet of each hydronic boiler.
   1. Two inlets and two outlets of each chiller.
   2. Inlet and outlet of each hydronic coil in air-handling units.
   3. Outside-, return-, supply-, and mixed-air ducts.

M. Install thermometers in air duct systems on flanges.

N. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

O. Provide instruments with scale ranges selected according to service with largest appropriate scale.

P. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

Q. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

R. Locate test plugs adjacent to pressure gauges and pressure gauge taps.

END OF SECTION 230519

SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Globe valves.

B. Ball valves.

C. Butterfly valves.

D. Check valves.

E. Gate valves.

F. Chainwheels.

1.02 RELATED REQUIREMENTS

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

B. Section 230719 - HVAC Piping Insulation-CPL.

C. Section 232113 - Hydronic Piping.

1.03 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. 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; 2026.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.

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; 2025.

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).

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 (Reapproved 2025).

L. AWWA C606 - Grooved and Shouldered Joints; 2022.

M. MSS SP-45 - Drain and Bypass Connections; 2020.

N. MSS SP-67 - Butterfly Valves; 2022.

O. MSS SP-68 - High Pressure Butterfly Valves with Offset Design; 2021.

P. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.

Q. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

R. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.

S. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.05 SUBMITTALS

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

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

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

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.06 QUALITY ASSURANCE

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

1.07 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.
   6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
   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. 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. Throttling (Hydronic): Butterfly, Ball, and Globe.

2. Throttling (Steam): Gate.
3. Isolation (Shutoff): Butterfly and Ball.
4. Swing Check (Pump Outlet):
   a. Size 2 inch and Smaller: Bronze with bronze disc.
   b. Size 2-1/2 inch and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
5. Dead-End: Butterfly, single-flange (lug) type.

C. Required Valve End Connections for Non-Wafer Types:
1. Steel Pipe:
   a. Size 2 inch and Smaller: Threaded ends.
   b. 2-1/2 NPS and Larger: Grooved ends or flanged.
2. Copper Tube:
   a. Size 2 inch and Smaller: Threaded ends, except solder-joint valve-ends.
   b. Size 2-1/2 inch and Larger: Grooved ends.
3. Steam and Steam Condensate Pipe: Grooved ends not acceptable.

D. Chilled Water Valves:
1. Size 2 inch and Smaller, Brass and Bronze Valves:
   a. Threaded ends.
   b. Ball: Full port, two piece, stainless steel trim.
   c. Swing Check: Bronze disc, Class.
   d. Globe: Bronze disc, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
   a. 2-1/2 inch to 4 inch: Flanged ends.
   b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
   c. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
   d. Swing Check: Metal seats, Class 125.
   e. Grooved-End Check: 3 inch to 12 inch, 300 CWP.

E. Heating Hot Water Valves:
1. Size 2 inch and Smaller, Brass and Bronze Valves:
   a. Threaded ends.
   b. Ball: Full port, two piece, stainless steel trim.
   c. Swing Check: Bronze disc, Class 125.
   d. Globe: Bronze disc, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
   a. 2-1/2 inch to 4 inch: Flanged ends.
   b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
   c. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
   d. Swing Check: Metal seats, Class 125.
   e. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.

2.02 GENERAL REQUIREMENTS

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

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
1. Gear Actuator: Quarter-turn valves 8 inch and larger.
2. Handwheel: Valves other than quarter-turn types.

3. Hand Lever: Quarter-turn valves 6 inch and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: Provide 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.
3. Butterfly Valves: Extended neck.
4. Memory Stops: Fully adjustable after insulation is installed.

E. Memory Stops: Fully adjustable after insulation is installed.

F. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.
5. Grooved End Connections: AWWA C606.

G. General ASME Compliance:
1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
2. Building Services Piping Valves: ASME B31.9.

H. Bronze Valves:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

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

J. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE, GLOBE VALVES

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

2.04 IRON, GLOBE VALVES

A. CWP Ratings: Class 125: 200 psi and Class 250: 500 psi:
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.

2.05 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Stainless Steel Trim:

1. Comply with MSS SP-110.
2. WSP Rating: 150 psi.
3. WOG Rating: 400 psi.
4. Body: Forged bronze or dezincified-brass alloy.
5. End Connections: Pipe thread or solder.
6. Seats: PTFE.
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.

2.06 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Wafer and Lug Style:
1. Class 125 or 150.
2. Comply with MSS SP-67, Type I.
3. Wafer Style, CWP Ratings:
   a. Sizes 2 to 12 inches: 200 psi.
   b. Sizes 14 to 24 inches: 150 psi.
4. Lug Style, CWP Ratings:
   a. Sizes 2 to 12 inches: 250 psi.
   b. Sizes 14 to 24 inches: 150 psi.
5. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
6. Stem: One or two-piece stainless steel.
7. Seat: NBR.
8. Disc: Aluminum-bronze.

2.07 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.

2.08 HIGH-PERFORMANCE, SINGLE FLANGE BUTTERFLY VALVES

A. Lug type; Bidirectional dead end service without downstream flange:
1. Comply with MSS SP-68.
2. Class 150: CWP Rating: 285 psi at 100 degrees F.
3. Body: Provide carbon steel or stainless steel.
4. Seat: Reinforced PTFE.
5. Offset stem: Stainless steel.
6. Disc: Stainless steel.

2.09 BRONZE, SWING CHECK VALVES

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. Gasket: Asbestos free.

2.11 IRON, GROOVED-END SWING CHECK VALVES

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

2.12 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. Install check valves where necessary to maintain direction of flow as follows:
   1. Swing Check: Install horizontal maintaining hinge pin level.

D. Provide chainwheels on operators for valves 4 NPS and larger where located 96 inches or more above finished floor, terminating 60 inches above finished floor.

END OF SECTION 230523

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components.

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 A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

E. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2025.

F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.

G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).

H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

L. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

M. FM (AG) - FM Approval Guide; Current Edition.

N. MFMA-4 - Metal Framing Standards Publication; 2004.

O. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

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

Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

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 013300 - SUBMITTAL PROCEDURES for submittal procedures.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Fiberglass strut systems.
   4. Pipe stands.
   5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Include design calculations for designing trapeze hangers.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

E. 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.

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

C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

D. Installer Qualifications for Field-Welding: As specified in Section 055000.

E. 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 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 - 22
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.02 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 plumbing 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 with a minimum safety factor of 4.0. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   5. 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. Prefabricated Trapeze-Framed Metal Strut Systems:
   1. Manufacturers:
      a. Ferguson Enterprises Inc: www.fnw.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.
   2. Strut Channel or Bracket 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.

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. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

D. Channel Nuts:
1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.

E. Hanger Rods:
1. Threaded zinc-plated steel unless otherwise indicated.
2. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2 inch diameter.
   b. Piping up to 1 inch: 1/4 inch diameter.
   c. Piping larger than 1 inch: 3/8 inch diameter.
   d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.

F. Thermal Insulated Pipe Supports:
1. Manufacturers:
   a. Buckaroos, Inc: www.buckaroos.com/#sle.
   b. KB Enterprises: www.snappitz.com/#sle.
   c. Substitutions: See Section 016000 - Product Requirements.
2. General Requirements:
   a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
   b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
   c. Pipe supports to be provided for nominally sized, 1/2 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.

G. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up To 122 degrees F:
   a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
   b. Support From Below: MSS SP-58 Types 35 through 38.
3. 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.

H. Roller Chairs:
1. MSS SP-58 type 43 based on required load, nonconductive and corrosion resistant.
2. Steel Yoke Type: MSS SP-58 type 44, vertically adjustable, nonconductive, and corrosion resistant.
3. Material: Zinc plated ASTM A36/A36M carbon steel or ASTM A47/A47M malleable iron.

I. Pipe Stanchions:
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
3. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.

J. Beam Clamps:
1. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
2. Beam C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
3. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).
4. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
5. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
6. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish,
7. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
8. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

K. Riser Clamps:
1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

L. U-Bolts:
1. MSS SP-58 Type 24, carbon steel u-bolt for pipe support or anchoring.

M. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.

N. Strut Clamps:
1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.

O. Insulation Clamps:
1. Two bolt-type clamps designed for installation under insulation.
2. Material: Carbon steel with epoxy copper or zinc finish.

P. Pipe Hangers:
1. Split Ring Hangers:
a. Provide hinged split ring and yoke roller hanger with epoxy copper or plain finish.

b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
c. Provide hanger rod and nuts of the same type and material for a given pipe run.
d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

2. Band Hangers, Adjustable:
   a. MSS SP-58 Type 7 or 9, Zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
3. Swivel Ring Hangers, Adjustable:
   a. MSS SP-58 Type 10, epoxy-painted, zinc-colored.
   b. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
   c. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.
4. Clevis Hangers, Adjustable:
   a. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.
   b. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.

Q. Intermediate Pipe Guides:
1. Pipe Diameter 6 inch and Smaller: Provide minimum clearance of 0.16 inch.
2. Pipe Sizes 8 inch: 0.625 inch U-bolt with double nuts providing minimum clearance of 0.28 inch.
3. Pipe Size 10 inch: 0.75 inch U-bolt.
4. Pipe Sizes 12 to 16 inch: 0.875 inch U-bolt.
5. Pipe Sizes 18 to 30 inch: 1 inch U-bolt.
6. Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.

R. Pipe Alignment Guides:
1. Pipe Sizes 8 inch and Smaller: Spider or sleeve type.

S. 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.

T. Pipe Shields for Insulated Piping:
1. 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.

U. 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. Sheet Metal: Use sheet metal screws.
9. Wood: Use wood screws.
10. Plastic and lead anchors are not permitted.
11. Hammer-driven anchors and fasteners are not permitted.
12. 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.
13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

V. Pipe Installation Accessories:
1. Copper Pipe Supports:
2. Thermal Insulated, Surface-Mounted Pipe Supports:
    a. Material: Carbon steel with epoxy copper or zinc finish.
    b. Weather and UV light resistant foam, plastic, or rubber material with built-in strut. Maximum Load: 50 lb for single pipe or multiple landed on top strut.

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 230529

SECTION 230530
HVAC ROOFTOP SUPPORT SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Portable, non-penetrating, rooftop support system for:
   1. Piping.
   2. Conduits and cables.
   3. HVAC equipment.

B. Seismic and High Wind application for items listed above.

1.02 RELATED REQUIREMENTS

A. Section 077100 - Roof Specialties.

B. Section 077200 - Roof Accessories.

C. Section 230529 - Hangers & Supports for HVAC.

1.03 REFERENCE STANDARDS

A. ASTM A 123/A - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. ASTM A 653 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. MSS SP-58 - Pipe Hangers and Supports -- Materials, Design and Manufacturer; Manufacturers Standardization Society of the Valve and Fittings Industry.

D. MSS SP-69 - Pipe Hangers and Supports -- Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry.

1.04 SYSTEM DESCRIPTION

A. Support piping on roof with an engineered prefabricated Rooftop Support System designed for installation without roof penetration, flashing or damage to the roofing material where possible. The system shall consist of bases, made of recycled rubber, a galvanized steel frame and suitable pipe hangers for the application. The system shall be designed to not exceed 2 psi at each base. Nuts, threaded rods and washers shall be galvanized, channel nuts and bolts for spring nuts will be electro-plated. System shall be custom designed to fit piping and conduit to be installed.

1.05 SUBMITTALS

A. Product Data: Submit for all products proposed for use, describing physical characteristics and method of installation.

B. Shop Drawings: Show installation layout, sizes of units, and details of installation.

C. Delegated-Design Submittal: Comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Refer to section 230550 Wind Restraint for HVAC Systems

1.06 QUALITY ASSURANCE

A. Pre-Installation Meeting: After approval of submittals, but before beginning installation, conduct a meeting at the project site attended by Architect, Contractor, installers of roofing, and mechanical and electrical piping, to be installed on pipe support systems.
   1. Purpose of meeting is to describe in detail the installation process and to establish agreement, coordination, and responsibilities.
   2. Prepare detailed meeting report and distribute copies to the Architect and all attendees.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials to project site in manufacturer's original packaging, marked with manufacturer's name, and other related information.

B. Store materials under cover until needed for installation.

1.08 WARRANTY

A. Warranty: Manufacturer's 10-year limited warranty on pre-galvanized and 20-year limited warranty on HDG to repair or replace, at manufacturer's option, any products the manufacturer finds to be structurally defective in material or workmanship. Warranty is not valid if System was modified, installed incorrectly, or not designed by product manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. EBERL Iron Works, INC - Rooftop Support Systems.

B. NOVIA Corporation.

C. PHP Systems/Design.

2.02 APPLICATIONS

A. Support pipes, conduit, cable trays, and ducts minimum of 6 inches above roof surface.
   1. Support Spacing: 8 feet MAXIMUM.
   2. For Electrical and Gas Lines 3-1/2 inches in Diameter or less, up to 16 inches above roof: Bridge Pipe Supports.
   3. For single Electrical and Gas Lines 4 to 8 inches in Diameter: Model: Double Cross Brace Supports.
   4. For Multiple Lines: Bridge Pipe Supports or Double Cross Brace Supports.
   5. For Ductwork: Single or Double cross brace.
   6. Accessories for Custom and Other Applications when required:
      a. On Sloped Roof Surfaces, Where Slope Exceeds 1/4 inch per foot: Rooftop Support Systems is not approved for use.
      b. Un-insulated Piping: Roller support or clevis hanger.
      c. Insulated Piping: Band hanger supported from horizontal channel or clevis hanger with pipe saddle.

B. Attachment of Base to Roof Surface when required for Seismic and High Wind Application: Mechanically fastened to roof deck.

2.03 MATERIAL

A. Rooftop Support System: Engineered, portable system specifically designed for installation without the need for roof penetrations or flashings, and without causing damage to the roofing membrane where possible.
   1. Design system using recycled rubber.
   2. Steel framing for support is 1-5/8 inch P1000H3
   3. Custom design system to fit piping, conduits, equipment, or walkways to be installed and actual conditions of service and loading.
   4. Piping Supports: Provide suitable hangers and supports.
   5. Duct and Equipment Supports: Factory fabricated to support exact duct sizes and equipment to be installed.

B. Bases: compression molded recycled rubber, conforming to the following:
   1. Moisture Content: Negligible.
   2. Shrinkage/Swelling Due to Moisture: Negligible.
   3. Insect Resistance: No known insect damage potential.
   4. Chemical Resistance (oil, brake fluid, gasoline, diesel, antifreeze, battery acid, and sulfuric acid) No visual or physical change apparent.

5. Sized as required by loading conditions and as indicated on the drawings.
6. Shop fabricated with inserts for square tubing or threaded rods as required.
7. Color: Integral black color as molded.
8. Bases for Mechanical Attachment: Solid Steel

C. Stainless Steel Framing:
1. Channel Types: 1-5/8 inch, or as required for loading conditions.
2. Thickness: 12 gauge.
3. Form: Roll-formed 3-sided or tubular channel.
4. Finish: Mill finish.
5. Do not use tubing or tube steel.

D. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69 and as follows:
1. Fabricate of carbon steel where framing is carbon steel; fabricate of stainless steel where framing is stainless steel; finished same as framing.
2. Sizes 2-1/2 inch and smaller: Single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
3. Sizes 3 inch and larger: Rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.

E. Accessories: Clamps, bolts, nuts, washers, and other devices as required for a complete system.
1. Carbon Steel: Pre-galvanized in accordance with ASTM A653.
2. Carbon Steel: Hot-dip galvanized in accordance with ASTM A123.

F. Stainless Steel: Mill finish.
1. For Mechanical Fastening to Deck: On wood and steel decks, use bolts with steel plate to attach to deck; on concrete decks use anchors that adhere to loading requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that roofing system is complete and that roof surfaces are smooth, flat, and ready to receive work of this section.

3.02 PREPARATION

A. Clean surfaces of roof in areas to receive support bases.
1. Sweep loose gravel from gravel surfaced roofs.
2. Remove dirt, dust, oils, and other foreign materials.

B. Use care in handling support system components during installation, to avoid damage to roofing, flashing, equipment, or related materials.

3.03 INSTALLATION

A. Pipe, Duct, Cable, and Equipment Support Systems:
1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping, ducts, and conduit, whether or not all required devices are shown.
2. The use of wood for supporting piping is not permitted.
3. Provide supports spaced so deflection of piping does not exceed 1/240 of span.
4. Install framing at spacing indicated, but in no case at greater than 8 feet on center 5.
5. Accurately locate and align bases.
a. Consult manufacturer of existing or new roofing system as to the type of isolation pads required between the roof and base.
b. Set isolation pads in adhesive if required by manufacturer's instructions.
c. Place bases on isolation pads.

d. Adhere or mechanically attach if required by code.
e. Where applicable, replace gravel around bases.

6. Set framing posts into bases and assemble framing structure as indicated.
7. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.

3.04 FIELD QUALITY CONTROL

A. When requested by the Architect, provide a factory-trained representative of the manufacturer to visit the site while the work is in progress to assure that the installation conforms to the design requirements and the manufacturer's installation requirements.

3.05 CLEANING AND PROTECTION

A. Remove all packaging, unused fasteners, and other installation materials from the project site.

B. Provide protection as required to leave the work area in undamaged condition at the time of completion of work.

SECTION 230550
WIND RESTRAINT FOR HVAC SYSTEMS - NYS 2025

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 7-22.

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. 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 2 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): 124 mph.
   2. Risk Category: III.
   3. Exposure Category: B.

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 3 EXECUTION

3.01 INSTALLATION

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

END OF SECTION 230550

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Adhesive-backed duct markers.

D. Pipe markers.

E. 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; 2025.

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 markers.

G. Instrumentation: Tags.

H. Major Control Components: Nameplates.

I. Piping: Pipe markers.

J. Pumps: Nameplates.

K. Relays: Tags.

L. Small-sized Equipment: Tags.

M. Tanks: Nameplates.

N. Thermostats: Nameplates.

O. Valves: Tags and ceiling tacks where located above lay-in ceiling.

P. 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 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.

2.06 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. HVAC Equipment: Yellow.
   2. Fire Dampers and Smoke Dampers: Red.
   3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

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

B. Prepare surfaces in accordance with Section 099123 for stencil painting.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 099123.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

F. Use tags on piping 3/4 inch diameter and smaller.
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.
   3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

G. Install ductwork with adhesive-backed duct markers. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

H. Locate ceiling tacks to locate dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 230553

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

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic 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; 2024, with Errata (2025).

C. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems; 2026.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

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 Provider.
   3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   4. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Identification and types of measurement instruments to be used and their most recent calibration date.
      d. Final test report forms to be used.
      e. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Logs: Submit at least twice a week to the Commissioning Provider.

E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

F. 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. Project altitude.
      j. Report date.

G. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.05 QUALITY ASSURANCE

A. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

B. ECCCNYS - 2025 Compliance: Applicable requirements in ECCCNYS - 2025, Section C408.2.2 - "Systems Adjusting and Balancing."

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. Certified by one of the following:
      a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.

b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Final filters are clean and in place. If required, install temporary media in addition to final filters.
4. Duct systems are clean of debris.
5. Fans are rotating correctly.
6. Fire and volume dampers are in place and open.
7. Air coil fins are cleaned and combed.
8. Access doors are closed and duct end caps are in place.
9. Air outlets are installed and connected.
10. Duct system leakage is minimized.
11. Hydronic systems are flushed, filled, and vented.
12. Pumps are rotating correctly.
13. 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.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

F. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 FUME HOOD TESTING (ON SITE)

A. General: Test fume hoods as installed to assess airflow velocity and airflow visualization. Perform tests with static mode (set sash position) and dynamic mode (sash movement effect) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.

B. 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.

C. Testing Requirements:
   1. Perform the following tests, in order:
      a. Airflow Velocity Test.
      b. Airflow Visualization Test.
   2. If more than one test procedure is selected, proceed to the next test only if any unsafe condition discovered during current test has been successfully rectified.
   3. Airflow Velocity Test: Comply with Section 9 of NEBB (FHT) Fume Hood Testing Standard - current edition.
   4. Airflow Visualization Test: Comply with Section 10 of NEBB (FHT) 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

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

E. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

F. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

G. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

H. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

I. Where modulating dampers are provided, take measurements and balance at extreme conditions.

J. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

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 Provider, upon request, any data gathered but not shown in the final TAB report.

E. Re-check a random sample equivalent to 25 percent of the final TAB report data as directed by Commissioning Provider.
   1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Provider.
   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 Provider, 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. Condensing Boilers.
3. Air Cooled Water Chillers.
4. Packaged Roof Top Heating/Cooling Units.
5. Air Coils.
6. Air Handling Units.
7. Fans.
8. Air Filters.
9. Air Terminal Units.
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 flow rate.
   7. Heat input.
   8. Percent carbon monoxide (CO).
   9. Percent carbon dioxide (CO2).
   10. Percent oxygen (O2).
   11. Percent excess air.
   12. Flue gas temperature at outlet.
   13. Ambient temperature.
   14. Percent combustion efficiency.
   15. Heat output.

E. Chillers:
   1. Identification/number.
   2. Manufacturer.
   3. Capacity.
   4. Model number.
   5. Serial number.
   6. Evaporator entering water temperature, design and actual.
   7. Evaporator leaving water temperature, design and actual.
   8. Evaporator pressure drop, design and actual.
   9. Evaporator water flow rate, design and actual.
   10. Condenser entering water temperature, design and actual.
   11. Condenser pressure drop, design and actual.

12. Condenser water flow rate, design and actual.

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. Air pressure drop, design and actual.

G. Heating Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

H. 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.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.

L. 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.

M. Terminal Unit Data:
1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.

5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.

N. 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 230593

SECTION 230713
DUCT INSULATION-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Duct liner.

C. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

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

C. Section 233100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

D. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

E. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2025.

F. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.

G. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2025.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

J. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

L. 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. Knauf Insulation; Performance+ Duct Wrap: www.knaufinsulation.com/#sle.
4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
5. 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: 250 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.owenscorning.com/en-us/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: ASTM C612; rigid, noncombustible.
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 pcf.

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 EXPANDED POLYSTYRENE INSULATION

A. Manufacturers:
1. Knauf Insulation.

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

2.05 JACKETING AND ACCESSORIES

A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
1. Lagging Adhesive:
a. Manufacturers:
1) Design Polymerics; DP 3050 Water Based, 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:
1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
2. Thickness: 0.016 inch sheet.
3. Finish: Smooth.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.06 DUCT LINER

A. Manufacturers:
1. Armacell LLC; ArmaFlex Ultima: 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. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
6. 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. Minimum Noise Reduction Coefficients:
a. 1 inch Thickness: 0.40.
b. 1-1/2 inches Thickness: 0.50.
c. 2 inch Thickness: 0.60.
5. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm when tested in accordance with ASTM C1071.
6. 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. Insulated Ducts Exposed in Mechanical Equipment Rooms, Electrical Rooms, Storage rooms, or Finished Spaces: Finish with aluminum jacket.

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 airflow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

A. Combustion Air Duct:
   1. Flexible Glass Fiber Duct Insulation:
      a. Thickness required to provide an R value not less than R-12.
   2. Rigid Glass Fiber Duct Insulation:
      a. Thickness required to provide an R value not less than R-12.
   3. Provide duct liner where shown on mechanical sheets.
      a. Thickness required to provide an R value not less than R-12.

B. Exhaust Ducts Within 10 ft of Exterior Openings:
   1. Flexible Glass Fiber Duct Insulation:
      a. Thickness required to provide an R value not less than R-12.
   2. Rigid Glass Fiber Duct Insulation:
      a. Thickness required to provide an R value not less than R-12.

C. 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.

D. Supply Ducts:
   1. First 10 ft from unit supply/return connections
      a. Duct Liner
         1) Thickness required to provide an R value not less than R-6.
   2. Other than first 10 ft from supply connection, where concealed:
      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. Provide duct liner where shown on mechanical sheets.
      a. Thickness required to provide an R value not less than R-6.
   4. In Mechanical Rooms:
      a. Rigid Glass Fiber Duct Insulation:
         1) Thickness required to provide an R value not less than R-6.
         2) Provide jacketing

E. Return and Relief Ducts:
   1. Provide duct liner where shown on mechanical sheets.
   2. In Mechanical Rooms:
      a. Rigid Glass Fiber Duct Insulation:
         1) Thickness required to provide an R value not less than R-6.
         2) Provide jacketing

F. Type I, Commerical Kitchen Hood Exhaust Ducts:
   1. Fire-Rated Blanket; thickness as required to achieve a 2-hour fire rating.

G. Ducts Exposed to Outdoors:
   1. Insulation:
      a. Expanded Polystyrene Insulation.
         1) Thickness required to provide an R value not less than R-12.
   2. Jacket:
      a. Aluminum Jacket or Flexible Weather-Proofing Outdoor Jacket

END OF SECTION 230713

SECTION 230716
HVAC EQUIPMENT INSULATION-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Equipment insulation.

B. Flexible removable and reusable blanket insulation.

C. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

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

B. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.

C. Section 232114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

F. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.

G. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

H. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.

I. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2025.

J. ASTM C1393 - Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks; 2025.

K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

L. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

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. See Section 013300 - SUBMITTAL PROCEDURES for submittal procedures.

C. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

D. 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.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturers:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville Corporation; _____: www.jm.com/#sle.
   3. Owens Corning Corporation; SOFTR Duct Wrap FRK: www.owenscorning.com/en-us/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: ASTM C553; flexible, noncombustible.
   1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum Service Temperature: 1,000 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Insulation: ASTM C1393; pipe and tank, end grain adhered to jacket.
   1. K Value: ASTM C177, 0.27 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   2. Secure with self-sealing longitudinal laps and butt strips.
   3. Secure with outward clinch expanding staples and vapor barrier mastic.

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.

2.03 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

A. Description: Custom cut and fabricated, removable and reusable blanket insulation system, consisting of inner liner, insulation layer, outer protective jacket, and fastening system.

B. Provide insulation system based on surface temperature of piping, installed location of piping, and maximum safe-to-touch temperature of jacketing.

C. Performance Criteria:
   1. Safe-to-Touch Temperature of Jacketing: 140 degrees F.

D. Components:
   1. Inner Liner: Use stainless steel mesh or silicone-impregnated fiberglass.
   2. Insulation:
      a. Material: Needled fiberglass felt mat.
      b. Thickness: 1 inch.
      c. Density: 11 pcf.
      d. Thermal Conductivity k-factor in Btu inch/hr sq ft degrees F: 0.50 at 500 degrees F.

2.04 GLASS FIBER, RIGID

A. Manufacturer:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville Corporation; _____: www.jm.com/#sle.
   3. Owens Corning Corporation: www.owenscorning.com/en-us/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
   1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum Service Temperature: 1,200 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.
   4. Maximum Density: 8.0 pcf.

C. Vapor Barrier Jacket:
   1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   2. Secure with self-sealing longitudinal laps and butt strips.
   3. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.05 CELLULAR GLASS

A. Pipe and Tubing Insulation: ASTM C552, Type II, Grade 6.
   1. K Value: 0.35 at 100 degrees F.
   2. Service Temperature Range: From 250 degrees F to 800 degrees F.
   3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
   4. Water Absorption: 0.5 percent by volume, maximum.
   5. Density: At least 6.12 pcf, minimum.

B. Block Insulation: ASTM C552, Type I, Grade 6.
   1. K Value: 0.35 at 100 degrees F.
   2. Service Temperature: 800 degrees F, maximum.
   3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
   4. Water Absorption: 0.5 percent by volume, maximum.
   5. Density: 6.12 pcf, minimum.

2.06 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Aeroflex USA; AEROFLEX EPDM Sheet/Roll: www.aeroflexusa.com/#sle.
   2. Armacell LLC; AP ArmaFlex: www.armacell.us/#sle.
   3. K-Flex USA LLC; Insul-Sheet: 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, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Connection: Waterproof vapor barrier adhesive.

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

2.07 JACKETING AND ACCESSORIES

A. PVC Plastic:
   1. Jacket: Sheet material, off-white color.
      a. Minimum Service Temperature: Minus 40 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 10 mil, 0.010 inch.
      e. Connections: Brush on welding adhesive.
   2. Covering Adhesive Mastic: Compatible with insulation.

B. Aluminum Jacket:
   1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
   2. Thickness: 0.016 inch sheet.
   3. Finish: Smooth.
   4. Joining: Longitudinal slip joints and 2 inch laps.
   5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

C. Exposed Equipment: Locate insulation and cover seams in least visible locations.

D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated equipment containing fluids below ambient temperature; insulate entire system.

G. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

J. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

K. Inserts and Shields:
   1. Application: Equipment 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between hangers and inserts.
   3. Insert Location: Between support shield and equipment 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.

L. Finish insulation at supports, protrusions, and interruptions.

M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting or PVC jacket and fitting covers.

N. Exterior Applications:
   1. Provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement.
   2. Cover with aluminum.

O. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

P. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

Q. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.03 SCHEDULE

A. Heating Systems:
   1. Heat Exchangers/Converters.
   2. Air Separators.

B. Cooling Systems:
   1. Pump Bodies.
   2. Air Separators.
   3. Expansion Tanks.

END OF SECTION 230716

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SECTION 230719
HVAC PIPING INSULATION-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Jacketing and accessories.

C. 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 232301 - Refrigerant Piping Specialties: Placement of inserts.

1.03 REFERENCE STANDARDS

A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2024).

F. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

G. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

H. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2025.

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; 2025.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

M. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

N. 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; Performance+ Earthwool 1000 Pipe Insulation: www.knaufinsulation.com/#sle.
4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.owenscorning.com/en-us/#sle.
5. Owens Corning Corporation; VaporWick Pipe Insulation: www.owenscorning.com/en-us/#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. 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.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

G. Fibrous Glass Fabric:
1. Cloth: Untreated; 9 oz/sq yd weight.
2. Blanket: 1.0 pcf density.
3. Weave: 5 by 5.

H. Indoor Vapor Barrier Finish:

1. Cloth: Untreated; 9 oz/sq yd weight.
2. Vinyl emulsion type acrylic, compatible with insulation, black color.

I. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

J. Insulating Cement: ASTM C449.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:
1. Aeroflex USA; AEROFLEX Self-Seal: www.aeroflexusa.com/#sle.
2. Armacell LLC; AP ArmaFlex: www.armacell.us/#sle.
3. K-Flex USA LLC; Insul-Tube: 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 JACKETING AND ACCESSORIES

A. PVC Plastic.
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.
2. Covering Adhesive Mastic: Compatible with insulation.

B. Aluminum Jacket:
1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
2. Thickness: 0.016 inch sheet.
3. Type: Factory-applied, self-adhesive jacketing.
4. Finish: Smooth.
5. Joining: Longitudinal slip joints and 2 inch laps.
6. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
7. 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, 0.002 inch.
b. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

2.05 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. 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. Indoor Heating Systems:
   1. Heating Water Supply and Return:
      a. NPS 1-1/4 and Smaller: 1-1/2 inch thick Rigid Glass Fiber.
      b. NPS 1-1/2 and Larger: 2 inch thick Rigid Glass Fiber.
   2. Boiler Feed Water:
      a. NPS 1-1/4 and Smaller: 1 inch thick Rigid Glass Fiber.
      b. NPS 1-1/2 and Larger: 1-1/2 inch thick Rigid Glass Fiber.

B. Indoor Cooling Systems:
   1. Chilled Water:
      a. NPS 3 and Smaller: 1-1/2 inch thick Rigid Glass Fiber with Vapor Barrier.
      b. NPS 4 to NPS 12: 2 inch thick Rigid Glass Fiber with Vapor Barrier.
   2. Dual Temperature Water:
      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.
   3. 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.
   4. Refrigerant Suction:
      a. All Sizes: 1-1/2 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
   5. Refrigerant Hot Gas:
      a. All Sizes: 1-1/2 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
   6. Refrigerant Liquid:
      a. All Sizes: 1 inch thick Flexible Elastomeric Cellular.

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

END OF SECTION 230719

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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 Provider (CxP) 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 RELATED REQUIREMENTS

A. Section 017900 - Demonstration and Training: Scope and procedures for Owner personnel training.

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

C. Section 230593 - Testing, Adjusting, and Balancing for HVAC-CPL.

D. Section 230913 - Instrumentation and Control Devices for HVAC.

E. Section 230923 - Direct-Digital Control System for HVAC.

F. Section 230993 - Sequence of Operations for HVAC Controls.

1.03 REFERENCE STANDARDS

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

1.04 SUBMITTALS

A. Updated Submittals: Keep Commisioning Provider (CxP) 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 Provider.

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 CxP in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by CxP.

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 CxP; update the schedule as appropriate.

D. Notify CxP 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 CxP has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.

G. Provide temperature and pressure taps in accordance with Contract Documents.

3.02 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by CxP 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.
8. Closure for Cooling Coil Valves - Normally Closed:
    a. Set cooling setpoint 20 degrees F above room temperature.
    b. Observe the valve close.
    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 cooling setpoint to 20 degrees F below room temperature.
    f. Observe valve open.
    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.
2. Method 3 - Coil Drain Down: Not for 3-way valves.
    a. Put systems in normal mode.
    b. If cooling coil valve, remove all call for cooling; if heating coil valve, put system in full cooling.
    c. Close isolation valve on supply side of coil, open air bleed cap, open drain-down cock and drain water from coil.
    d. If water does not stop draining, there may be a leak through the control valve.
    e. Return all to normal when done.

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 CxP 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 CxP.

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 CxP during testing of controlled equipment; coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

G. Demonstrate to CxP:
   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. Fire alarm interlocks and response.
14. That points that are monitored only, having no control function, are reporting properly to the control system.
15. All control strategies and sequences not tested during controlled equipment testing.
16. Trend logging and graphing features that are specified.
17. Other integrated tests specified in Contract Documents

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 Provider for review; make changes recommended by Commissioning Provider.

D. Commissioning Provider will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 017900 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to CxP during Functional Testing.

D. 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.

E. Provide the services of manufacturer representatives to assist instructors where necessary.

F. 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 230800

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SECTION 230913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Control panels.

B. Control Valves:
   1. Ball valves with factory-mounted actuators.
   2. Butterfly valves with factory-mounted actuators.
   3. Electronic valve operators.

C. Pressure independent valves and actuators.

D. Dampers.

E. Damper Operators:
   1. Electric operators.

F. Wall-, Surface-, and Duct-Mounted Sensors:
   1. Temperature sensors.
   2. Humidity sensors.
   3. Building static pressure transmitters.
   4. Static air pressure sensors.
   5. Air pressure transmitters.
   6. Airflow meters; pitot tubes.
   7. Airflow meters; thermal dispersion.
   8. Damper position indicators.
   9. Carbon dioxide sensors.

G. Fan and pump motor run-status monitoring.

H. Pipe-Mounted Sensors and Transmitters:
   1. Temperature sensors.
   2. Pressure transmitters.
   3. Differential pressure transmitters.
   4. Flow switches.

I. Thermal Dispersion Airflow Meters

1.02 RELATED REQUIREMENTS

A. Section 230519 - Meters and Gauges for HVAC Piping-CPL: Thermometer sockets and gauge taps.

B. Section 232113 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, and gauge taps.

C. Section 232114 - Hydronic Specialties.

D. Section 233300 - Air Duct Accessories.

1.03 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. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

E. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

1.04 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 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.

1.05 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.

1.06 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

2.01 EQUIPMENT - GENERAL

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

2.02 CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.

B. NEMA EN 10250, general purpose utility enclosures with enameled finished face panel.

C. Provide common keying for all panels.

2.03 CONTROL VALVES

A. Segemented and Characterized Ball Valves with Factory-Mounted Actuators:
   1. Manufacturers:
      a. Belimo Aircontrols (USA), Inc; _____: www.belimo.com/#sle.
      b. Johnson Controls International, PLC; _____: www.johnsoncontrols.com/#sle.
      c. Schneider Electric; _____: www.schneider-electric.us/#sle.
   2. Service: Use for chilled water or hot water.
   3. Flow Characteristic: Fully proportioning, equal percentage.
   4. Flow Characteristic: Include 2-way operation.
      a. Heating Hot Water: Configure to fail normally open.

b. Chilled Water: Configure to fail normally closed.
5. Provide pressure-independent type.
6. Rangeability: 500 to 1.
7. Leakage: Tested in accordance with ANSI/FCI 70-2.
   a. Straight-Through Flow on 2-Way Valves: Class IV.
8. Service Temperature Range: Minus 20 to 250 degrees F.
9. Valve Body:
   a. Under 2-1/2 inches:
      1) Connection: NPT.
      2) Pressure Rating: 400 psi.
      3) Materials:
         (a) Body: Brass.
         (b) Ball: 300 series stainless steel.
         (c) Stem: 300 series stainless steel.
         (d) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
         (e) Stem Seal: EPDM O-Rings.
         (f) Flow Control Disk: Thermoplastic synthetic-resin.
   b. 2-1/2 inches and Above:
      1) Connection Type: Flanged.
      2) ANSI Rating: Class 125 or 150.
      3) Materials:
         (a) Body: Manufactured from brass with ductile iron flanges, cast iron, carbon steel, or stainless steel.
         (b) Ball: 300 series stainless steel.
         (c) Stem: 300 series stainless steel.
         (d) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
         (e) Stem Seal: EPDM O-Rings.
         (f) Flow Control Disk: Thermoplastic synthetic-resin.
   c. Service Temperature:
10. Hydronic Systems: Size for 3 psig maximum pressure drop at design flow rate.
11. Actuator Requirements:
    a. Assembly: Factory-mounted.
    b. Input: 0 to 10 VDC configured for proportional control.
    c. Accessories: Provide with valve position indicator and manual override.

B. Butterfly Valves with Factory-Mount Actuators:
   1. Iron body, bronze disc, resilient replaceable seat for service to 250 degrees F wafer or lug ends, extended neck.
   2. Hydronic Systems:
      a. Rate for service pressure of 125 psig at 250 degrees F.
      b. Size for 1 psig maximum pressure drop at design flow rate.

C. Electronic Valve Actuators:
   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.

2.04 PRESSURE INDEPENDENT VALVES AND ACTUATORS

A. 6-Way Pressure Independant Control Valve NPS 1 and Smaller:
   1. Materials:
      a. Body: Forged brass.
      b. Ball: Chrome plated brass.

c. Seats/Seals: PTFE (TeflonTM), (4) EPDM O-rings.
d. Stem/Extension/Seals:
1) Nickel plated brass;
2) Lubricated EPDM O-Rings (4).
e. Characterizing Disc: Chrome plated steel.
2. Piping Connections: (6), female NPT
3. Media: Water
4. Performance:
a. Media Temperature: 43°F to 180 °F (6°C to plus 82°C)
b. Pressure:
1) Body: 232 psig (1599 kPa);
2) Maximum Operating Differential: 15 psid (103 kPa);
3) Close-off (valve and actuation assembly): 50 psig (344 kPa).
c. Leakage (A-AB): 0%.
d. Flow Characteristic: Linear.
5. Controllable Flow Range: Sequence 1 is 0 to 30 degree angle; Dead zone is 30 to 60 degree angle; Sequence 2 is 60 to 90 degree angle.
6. Flow Meter: An ultrasonic flow meter (accuracy +/- 2%) shall be integrated with a 6-way characterized control valve providing analog flow feedback. The valve shall reposition to maintain the required flow with a +/- 6% accuracy over a pressure differential range of nominal 7 to 35 psig (34 to 241 kPa). The flow meter shall incorporate an algorithm to automatically compensate for the glycol concentration.
7. Labeling: Valve body shall be furnished with a label containing the following data:
a. Manufacturer's name and model number;
b. Nominal size.

B. Size 2 inch and Smaller:
1. Provide ball style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.

C. Size 2.5 inch and Larger:
1. Provide butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

D. Actuator Requirements:
1. Assembly: Factory-mounted.
2. Input: 0 to 10 VDC configured for proportional control.
3. Accessories: Provide with fail-safe battery pack, manual override, and valve position indicator.

2.05 DAMPERS

A. See Section 233300 for dampers and this section for actuators and operators.

2.06 DAMPER OPERATORS

A. General:
1. Provide actuators with torque capacity sized for minimum of 20 percent greater than maximum design stream velocity and hold tight seal against maximum system pressures.
2. Provide spring return for two position control and for fail safe operation.

3. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
4. 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.

2.07 WALL-, SURFACE-, AND DUCT-MOUNT 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. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
d. Room Temperature Sensors:
1) Construct for surface mounting.
2) Provide the following:
(a) Setpoint reset slide switch with an adjustable temperature range.
(b) Momentary override request push button for activation of after-hours operation.
e. Temperature Averaging Elements:
1) Use on duct sensors for ductwork 10 sq ft or larger.
2) Use averaging elements where prone to stratification with sensor length 8 ft or 16 ft.
3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
f. Insertion Elements:
1) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.

B. Humidity Sensors, Outdoor-Mount:
1. Digitally profiled thin-film capacitive sensor encased in a die-cast metal, weather-proof plastic or metal housing with solar shield.
2. Measuring Scale: 0 to 100 percent RH, noncondensing, temperature compensated.
3. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
4. Accuracy: Plus/minus 1 percent between 20 to 40 percent RH linear range, NIST traceable with multi-point calibration.

C. Humidity Sensors, Duct-Mounted:

1. Digitally profiled thin-film capacitive sensor probe extended from die-cast metal, weather-proof plastic or metal housing designed for duct mounting.
2. Measuring Scale: 0 to 100 percent RH, noncondensing, temperature compensated.
3. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
4. Accuracy: Plus/minus 1 percent between 20 to 40 percent RH linear range, NIST traceable with multi-point calibration.

D. Humidity Transmitters, Surface-Mounted:
1. Plastic housing encased, wall-mounted, humidity and temperaturesensor.
2. Humidity Sensor Type: Thin-film capacitive.
3. Accuracy: 1 percent at rated measuring scale and capable of withstanding 95 percent relative humidity without loss of calibration.
4. Output: Two-wire, 4 to 20 mA, 0 to 5 VDC or 0 to 10 VDC, non-loop powered, selectable.

E. Building Static Pressure Transmitters:
1. Single port for direct or tubing connection into wall or ceiling static pressure tip, direct acting, double bell, scale range 0.01 to 6.0 in-wc positive or negative, and sensitivity of 0.0005 in-wc. Transmit electronic signal to receiver with matching scale range.

F. Static-Air Pressure Sensors:
1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
3. Accuracy: One percent of full scale with repeatability 0.3 percent.
4. Output: 0 to 5 vdc with power at 12 to 28 vdc.

G. Air Pressure Transmitters:
1. General: Provide dry air media, differential pressure transducers to monitor duct and room pressure.
2. Accuracy: Plus/minus 2 percent full scale of range with combined linearity and hysteresis.
3. Zero Adjust: Pushbutton auto-zero and digital input using 2-position terminal block.
4. Measuring Range: 1 to 10 in-wc, unidirectional or bidirectional.
5. Hardwired Output: 2-wire, loop-powered 4 to 20 mA, field selectable.

H. Airflow Meters; Thermal Dispersion:
1. Manufacturer's:
   a. Basis of Design: EBTRON models GTx116-P+, GTx-108FI and GTx116e-PC.
   b. Approved equals: Sierra and Kurz.
2. General:
   a. Provide one thermal airflow measuring device (AMD) for each location indicated on plans, schedules and/or control diagrams. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
   b. Each AMD shall use the principal of thermal dispersion to determine the actual or mass airflow rate of the airstream. Differential pressure-based devices, including pitot tubes, pitot arrays, piezo-rings and devices measuring the pressure drop across a louver, damper or obstruction are not acceptable.
   c. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. The airflow of each sensor node shall be determined using one self-heated and ambient temperature sensing thermistor. Devices using indirectly heated thermistors to determine the airflow rate are not acceptable. Devices using chip thermistors of any type or packaging are not acceptable. Devices using platinum wire RTDs or similar “hot wire” devices are not acceptable.
   d. All internal wiring in the probe tube shall be chemical and abrasion resistant Kynar® coated copper.

e. All connections to internal wires in the probe tube shall be solder joints or welds. Connectors of any type in the probe tube are not acceptable.
f. Each thermistor shall be independently calibrated to NIST traceable temperature standards to establish the resistance-temperature characteristics for the determination of airflow and temperature. Devices using interchangeable, curve-matched, thermistors are not acceptable.
g. The airflow sensing thermistor of each sensor node shall be self-heated. Devices using Indirectly heated thermistors are not acceptable.
h. Remote transmitters shall be mounted in a location protected from moisture, rain and snow with an ambient temperature between -20 and 120 °F [-28.9 to 48.9 °C] and a humidity range between 5 and 95% RH (non-condensing). Provide a weatherproof enclosure and mount away from direct sunlight when outdoor mounting is required.
i. Probes with remote transmitters shall be “plug and play”, not require matching to the transmitter, and be provided with a UL listed, FEP jacketed, plenum rated cable and connector plug. Devices using PVC jacketed cables to connect sensor probes to the transmitter are not acceptable.
j. Each AMD shall be UL/cUL listed as a final assembly and FCC-Part 15 compliant. Compliance shall be demonstrated by an independent test laboratory.

3. Hardware
   a. Each AMD shall utilize thermal dispersion technology to measure velocity. Pressure differential systems, including piezo rings and pitot tubes, shall not be acceptable.
   b. Probes shall be suitable for installation in ducts, plenums, air handling equipment and outdoor air intakes to determine the airflow rate and velocity weighted temperature of the airstream.
   c. Provide one to four gold anodized 6063 aluminum probes and one remote transmitter.
   d. Each sensor node shall be individually wind-tunnel calibrated at 16 points to NIST traceable airflow standards and have an accuracy of ±2% of reading over the entire operating range. Provide a copy of the NIST calibration report for the reference standard used to calibrate the production tunnels used to calibrate individual sensor nodes. Reference standards calibrated to third-party NIST traceable labs are not acceptable. Devices claiming AMCA certification are not acceptable.
   e. Provide up to 16 sensing nodes per measurement location as required for the opening size and published sensor density tables to achieve an installed airflow accuracy of ±3% (±5% of reading on close coupled outdoor air intakes) between 0 and 5,000 fpm [0 to 25.4 m/s] over a temperature range of -20 to 160 °F [-28.9 to 71.1 ºC] and a humidity range between 0 and 100% RH (non-condensing).
   f. Provide the velocity weighted temperature of the airstream with an accuracy of ±0.15 °F [0.08 °C].
   g. Provide low and high airflow alarms with a user defined setpoint and tolerance.
   h. Transmitter interface shall be two isolated, field selectable (4-20mA, 0-5/0-10 VDC) analog output signals (flow plus temperature, humidity, enthalpy, dewpoint or alarm) and one isolated RS-485, field selectable (BACnet MS/TP or Modbus RTU) network connection.
   i. Provide a Bluetooth, low-energy interface and free Android® or iOS® software that allows real-time airflow and temperature monitoring and airflow and temperature traverses. Software shall capture, save and/or e-mail airflow/temperature data, transmitter settings and diagnostics information.
   j. Fan Array and Single Fan Measurement.
      1) Each AMD shall be suitable for installation in fan inlets to determine the airflow rate and velocity weighted temperature of the airstream. Piezo rings are not acceptable.

2) Provide face, forward mount adjustable brackets for each sensor node. Mount styles shall not affect the airflow or sound performance of plenum fans.
3) Provide the following number of sensor nodes based on fan type. All sensors shall be connected to a single, remote transmitter. Fan array models shall calculate the airflow of each fan individually prior to outputting the total airflow rate and have a built-in alarm capable of removing a failed fan from the total airflow calculation.

I. Carbon Dioxide Sensors, Duct and Wall:
1. General: Provide nondispersive infrared (NDIR), diffusion sampling CO2 sensors with integral transducers and linear output.
2. Air Temperature: Range of 32 to 122 degrees F.
3. Relative Humidity: Range of 0 to 95 percent (noncondensing).
4. Power Input: Class 2; 12 to 30VDC or 24VAC 50/60 Hz; 100mA max.
5. Calibration Characteristics:
   a. Automatically compensating algorithm for sensor drift due to sensor degradation.
   b. Maximum Drift: 2 percent.
   c. User calibratable with a minimum calibration interval of 5 years.
6. Construction:
   a. Sensor Chamber: Noncorrosive material for neutral effect on carbon dioxide sample.
   b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
   c. Housing: High impact plastic.

2.08 FAN AND PUMP MOTOR RUN-STATUS MONITORING

A. Current Switches:
1. Mini Solid-Core: 2-State, On/Off digital output of motor status with adjustable trip point to detect belt loss or mechanical failure.
2. Mini Split-Core: 2-state, On/Off digital output of inverter-duty motor status with adjustable trip point to detect belt loss or mechanical failure.
3. Maximum AC Current Monitoring Value: As indicated on drawings.

B. Differential Pressure Switches:
1. Fan Status: Select for adjustable range between 0 to 5 in-wc across fan discharge and external or fan inlet. Include static pressure tips.
2. Pump Status: Select for adjustable range between 8 to 60 psi across pump discharge and suction sides. Include static pressure tips and 3-way valve manifold.

2.09 PIPE-MOUNTED SENSORS AND TRANSMITTERS

A. Temperature Sensors:
1. Pipe-mounted temperature probe tied to weather-resistant enclosure for direct insertion into compatible liquids or gases or inserted into intermediary thermal grease-filled pipe-well compatible with interfaced fluid.
2. Sensor Type: 1,000 ohm Platinum RTD.
3. Transmitter: Fitted within probe-interface enclosure, calibrated.
   a. Monitoring Range: 32 to 122 degrees F, adjustable.
   b. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
   c. Accuracy: Plus/minus three percent. adjustable on the transmitter end.
4. Accessories: Provide downstream PT test plug.

B. Pressure Transmitters:
1. Self-contained transducer for monitoring of pneumatic, gas, liquid, or steam service with proportional range scaled over selected electronic output.
2. Service Monitoring Range: 0 to 15 psig.

3. Wetted Material: Brass for general service or stainless steel for steam and corrosive.
4. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.

C. Differential Pressure Transmitters:
1. General: Provide wet media differential pressure transducers with 6 ft (1.83 m) armored cable, to allow local or 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: 125 mA, DC.
c. Output: 3-wire transmitter; 4 to 20 mA, 0 to 5V, or 0 to 10V, selectable,
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).
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 to 185 degrees F.
h. Enclosure: NEMA EN 10250, Type 4.

D. Flow Switches:
1. Repetitive Accuracy: Plus/minus 10 percent of actual flow setting.
2. Switch Actuation: Adjustable over the operating range and sized for the application, such that the setpoint is between 25 and 75 percent of the full range.
3. Provide Form C snap-action contacts, rated for the application.
4. Furnish nonflexible paddle with magnetically actuated contacts, rated for service at a pressure greater than the installed conditions.

PART 3 EXECUTION

3.01 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.

G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of exposed control sensors with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches. Refer to Section 262726.

C. Mount freeze protection thermostats using flanges and element holders.

D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

E. Provide separable sockets for liquids and flanges for air bulb elements.

F. Provide guards on thermostats in entrances.

G. Provide valves with position indicators and with pilot positioners where sequenced with other controls.

H. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors.

I. Provide isolation (two-position) dampers of parallel blade construction.

J. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

K. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

L. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

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

3.03 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 230913

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.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2026).

B. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2019h, with Editorial Revision (2022).

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

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

1.04 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. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
   3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
   4. 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. Manufacturer's Qualification Statement.

F. Installer's Qualification Statement.

G. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
   2. Include submittals data in final "Record Documents" form.

H. 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.

I. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 5 years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with minimum 5 years of documented experience.

D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.06 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Johnson Controls, Inc; _____: www.johnsoncontrols.com/#sle.

B. Schneider Electric; _____: www.schneider-electric.us/#sle.

C. Siemens AG, Building Technologies Division; _____: www.siemens.com/#sle.

2.02 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.

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

2.03 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. Hardware:
   1. Laptop:
      a. Laptop(s) to be provided by DDC controls manufacturer.
      b. Quantity: Provide allowance for 1 computer(s).
      c. Network Connection:
         1) Ethernet interface card.

2.04 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.
   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. Custom Application Controller:
1. General:
a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
b. Share data between networked, microprocessor based controllers.
c. 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.
d. Utilize real-time clock for scheduling.
e. Continuously check processor status and memory circuits for abnormal operation.
f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
g. 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 LED's 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. 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.

D. 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.
   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:
        1) VAV terminal units.
        2) Duct mounted heating coils.
        3) Zone dampers.
        4) Radiation.
    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.

2.05 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.

2.06 SYSTEM SOFTWARE

A. Operating System:
1. Concurrent, multi-tasking capability.
    a. Common Software Applications Supported: Microsoft Excel.
    b. Acceptable Operating Systems: Microsoft Windows.
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.
c. Capture or convert graphics from AutoCAD.

4. Standard HVAC Graphics Library:
a. HVAC Equipment:
1) Chillers.
2) Boilers.
3) Air Handlers.
4) Terminal HVAC Units.
5) Fan Coil Units.
b. Ancillary Equipment:
1) Fans.
2) Pumps.
3) Coils.
4) Valves.
5) Piping.
6) Dampers.
7) Ductwork.

5. Miscellaneous Building Control Graphics
a. Generator
b. Exterior Building Lighting

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.
      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:
        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:
(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 cab 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.
   2. Holiday or Special Schedules:
      a. Capability to define up to 99 schedules.
      b. Repeated annually.
      c. Length of each period is operator defined.

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:
         1) Custom messaging.

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 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. 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.
6. 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. Occupancy and vacancy times.
7. HVAC point summary:
   a. Control system identifier and status.
   b. Point ID and status.
   c. Outside air temperature point ID and status.
   d. Calculated optimal start and stop times.

C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, and 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.

D. Enthalpy Switchover:
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 heating override switch.
   k. Add/delete air flow rate.
   l. Define enthalpy deadband.
   m. 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 cool enthalpy using outside air.
   g. Calculated cooling cool 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 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 4 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 four 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 4 complete normal inspections of approximately 4 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

END OF SECTION 230923

SECTION 230934
VARIABLE-FREQUENCY MOTOR CONTROLLERS-CPL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

A. Section 230529 - Hangers and Supports for HVAC Piping and Equipment-CPL.

B. Section 230553 - Identification for HVAC Piping and Equipment-CPL: Identification products and requirements.

C. Section 260526 - Grounding and Bonding for Electrical Systems.

D. Section 260573 - Power System Studies: Additional criteria for selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.

D. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.

E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

F. 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; 2023.

G. NEMA IS 10033 - Industrial Control and Systems: Adjustable-Speed Drives; 2026.

H. NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).

I. NEMA IS 10035 - Application Guide for AC Adjustable Speed Drive Systems; 2021 (Reaffirmed 2025).

J. NEMA MG 00001 - Motors and Generators; 2024.

K. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

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 013300 - SUBMITTAL PROCEDURES for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include wiring diagrams showing factory and field connections.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
1. Include contact information for entity providing contract maintenance and trouble call-back service.

F. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

G. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
1. Include nameplate data of actual installed motors and associated overload relay selections and settings.

H. Maintenance Materials: Furnish 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 products specified in this section with minimum three years documented experience.
1. Authorized service facilities located within 200 miles of project site.

C. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

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

1.08 FIELD CONDITIONS

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

1.09 WARRANTY

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

B. Provide minimum 18 month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB: www.abb.com/#sle.

B. Square D.

C. Yaskawa Electric Corp.

D. Substitutions: See Section 016000 - Product Requirements.

E. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Variable-Frequency Motor Controller:
   1. Configuration: Packaged controller with across-the-line bypass.
   2. Power Conversion System: 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.

1. 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.
4. Status Indications:
   a. Motor run/stop status.
   b. Motor forward/reverse status.
   c. Local/remote control status.
   d. Output voltage.
   e. Output current.
   f. Output frequency.
   g. DC bus voltage.
   h. Motor speed.
   i. Elapsed run time.
   j. Discrete input/output status.
   k. Analog input/output values.
5. Protective Functions/Alarm Indications:
   a. Overcurrent.
   b. Motor overload.
   c. Undervoltage.
   d. Overvoltage.
   e. Controller overtemperature.
   f. Input/output phase loss.
   g. Output short circuit protection.
   h. Output ground fault protection.
6. Inputs:
   a. Digital Input(s): Three.
   b. Analog Input(s): Two.
7. Outputs:
   a. Analog Output(s): One.
   b. Relay Output(s): Two.

8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
    a. Serial Communications: RS-485; support for Modbus RTU protocol.
    b. Ethernet Communications: Support for Modbus TCP protocol.
9. Features:
    a. Password-protected security access.
    b. Event log.

J. Power Conditioning/Filtering:
1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
2. Reactor Impedance: 3 percent, unless otherwise indicated or required.

K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.
    a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
    b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
    c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
2. Provide door-mounted remote operator interface.
3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
    a. Bypass Method: Manual, unless otherwise indicated.
    b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
    c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.
    d. Overload Relays: Solid state or bimetallic thermal type.
4. Pilot Devices Required:
    a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
    b. Packaged Controllers with Bypass:
        1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
        2) Motor Control Selector Switch: HAND/OFF/AUTO.
        3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.

L. Service Conditions:
1. Provide controllers and associated components suitable for operation under following service conditions without derating:
    a. Altitude: Less than 3,300 feet.
    b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

M. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as determined by short circuit study performed in accordance with Section 260573.

2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

N. Conductor Terminations: Suitable for use with conductors to be installed.

O. Enclosures:
1. Comply with NEMA 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.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Comply with NEMA ICS 2.
3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
4. Trip-free operation.
5. Visible trip indication.
6. Resettable:
a. Employ manual reset unless otherwise indicated.
b. Do not employ automatic reset with two-wire control.

2.04 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.

2.05 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.

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. 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.

END OF SECTION 230934

SECTION 230993
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.

B. Sequence of operation for:
   1. DOAS Units 1-11 (Displacement and Chilled Beam Terminal Units)
   2. DOAS Unit 12 (Energy Recovery Plate DOAS Units Serving Fan Coil Units)
   3. DOAS Units 13-14 (ERW DOAS Units Serving Fan Coil Units)
   4. DOAS Unit 15 (FACS Classroom)
   5. Rooftop Units 1, 2 (Gymnasium) & 3 (Auditorium)
   6. Rooftop Unit 4 (Library)
   7. Rooftop Unit 5 (Kitchen)
   8. Fan Coil Units 1-25 (DX or Chilled Water Cooling)
   9. Single-Zone Ductless Split Systems (SSI/SSO-1-8)
   10. Chilled Beam and Displacement Ventilation Terminal Units
   11. Unit Heaters
   12. Duct Mounted Heating Coils
   13. Fume Hood Exhaust Fans (EFs 1-5 & 9)
   14. Kitchen and Cafeteria Exhaust Fans (EFs 6 & 7, KEFs 1 & 2)
   15. FACS Classroom Range Hood Exhaust Fan (EF-8)
   16. Destratification Fans
   17. Condensing Boilers (B 1-3) and Heating Hot Water Pumps (P 1-5)
   18. Air Cooled Chiller (ACC-1) and Chilled Water Pumps (P 6-9)

1.02 RELATED REQUIREMENTS

A. Section 230913 - Instrumentation and Control Devices for HVAC.

B. Section 230923 - Direct-Digital Control System for HVAC.

1.03 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES for submittal procedures.

B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
   1. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in Contract Documents.
   2. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.

C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
   1. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.

D. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Sequences of operation specified herein, which indicate the functional intent of HVAC systems, subsystems, and/or components operation, are general in nature and may not fully define every aspect of programming that may be required to fulfill the design intent. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated, resulting in stable HVAC system operation in accordance with the design intent.

B. HVAC control set points are defined or implied within the sequences of operation specified hereinafter and/or elsewhere on the Drawings.
   1. Where a set point is not explicitly defined or implied, determine the appropriate set point based on scheduled performance data for HVAC equipment. Confirm set point with A/E.
   2. Defined or implied set points and set point reset requirements shall, as necessary, be adjusted based on test data provided by the testing/adjusting/balancing (TAB) subcontractor and control system calibration and verification testing as required by Section 230900 to provide stable, satisfactory HVAC systems operation in compliance with the design intent.
   3. AO set points and control ranges shall be user-adjustable.
   4. DO points that depend on a specific analog value to change shall be user-adjustable.
   5. The minimum speed setting for each pump and fan under VFD control shall be as low as possible, while avoiding inertial stalling. Adjust each VFD minimum speed and ramp-up and -down times based on test data provided by the TAB subcontractor. Default times for acceleration/deceleration shall be 30 seconds for motors less than 40 hp and 60 seconds for motors 40 hp and larger.

C. All systems shall maintain the scheduled or otherwise noted minimum outside air ventilation rate (based on applicable code requirements) during occupied hours.

D. Provide normally open hot water and normally closed chilled water control valves.

E. Provide normally open return air damper and normally closed outside air dampers and operators.

F. Mode of operation (occupied/unoccupied) including building warm-up and pull-down cycles, as well as all system functions shall be programmable and controlled by the DDC system.

G. Shutdown of air handling units and fans due to a fire alarm shall be by the Electrical Contractor. The fire alarm system will send a signal to the DDC system for monitoring purposes only. The DDC system will provide a staggered restart of the units once the alarm is cleared.

H. All setpoints shall be adjustable.

3.02 SITE CONDITIONS

A. Outdoor Air Condition Reference
   1. Locate sensors to monitor ambient (outdoor) air conditions on a north-facing wall of the building, sheltered from both direct sunlight and prevailing wind(s).
      a. Mount Barometric pressure sensor at least 8 feet above the roof and away from exhaust fans. Install sensor in a wind-proof enclosure.
   2. Monitor ambient outdoor air conditions as AI points:
      a. DB Temperature (ºF)
         1) Two (2) outside air temperature sensors are to be provided as general inputs to the DDC system. The pair of readings shall be averaged for use by the system. If an individual reading is found to be out of range by comparison, then the other reading shall be used, and an alarm shall be generated.

b. RH (%)
c. CO2 level (ppm)
d. Barometric pressure (in WC)

3. Compute enthalpy (Btu/Lb.) as a function of monitored DB and RH.
4. Compute DPT (ºF) as a function of monitored DB and RH.
5. Compute WB temperature (ºF) as a function of monitored DB and RH.
6. Monitor CO2 for reference to indoor air quality for HVAC systems that utilize demand ventilation.
7. Monitor outdoor pressure for reference to AHU unit building pressurization control to verify outdoor reference accuracy. If there is greater than 0.05" WC pressure difference in outdoor pressure measurements, initiate an alarm notification.

3.03 GENERAL OCCUPIED/UNOCCUPIED OPERATION

A. Scheduling:
1. All HVAC equipment shall operate in occupied/unoccupied modes as determined by the DDC building time clock system. Obtain the building occupancy schedule from the Owner.

B. Occupied/Unoccupied:
1. Occupied:
a. Units will be energized and will provide the proper ventilation as required during occupancy of the spaces. Setpoints will be as described for the individual areas for normal human comfort.
2. Unoccupied:
a. Equipment will be de-energized and outside air ventilation will be disabled. Temperature setpoints will be setback and equipment will maintain setback setpoints without ventilation.

C. Warm-up Mode:
1. The heating setpoint shall be incremented up from night heating setpoint to day heating setpoint.
2. The increment value shall be determined by outside air temperature and a user adjustable optimal start period and the difference between the occupied and unoccupied setpoints.
3. Once the heating setpoint exceeds the incremented setpoint warm-up shall commence.
4. The heating source shall be modulated to maintain occupied heating setpoint.

D. Post Occupancy Purge
1. The rooftop unit shall perform a 30-minute post occupancy purge when the unit goes into unoccupied mode. The supply and return/exhaust air fans shall remain on throughout this cycle. The return air damper shall modulate inversely in response to the outside air damper position. The exhaust air damper shall modulate in conjunction with the outside air damper. The heating and cooling equipment shall index according to their unoccupied sequences (see below) in order that at minimum, the purge shall meet the unoccupied temperature setpoint at completion of the purge.

3.04 DEMAND CONTROL VENTILATION – OCCUPIED MODES (DEMAND CONTROL):

A. NOTE: IF A SYSTEM IS EQUIPPED WITH MULTIPLE CO2 SENSORS, THE CO2 SENSOR WITH THE HIGHEST PPM READING SHALL BE USED FOR SEQUENCE BELOW.

B. Overview (specific values are contained in further articles of this section):
1. The HVAC system sequence of operations steps for normal thermal control is unchanged by incorporation of the outside air quantity/ventilation control sequences below. The control sequences below represent a function that will override the normal thermal controls as required to maintain outside air requirements during occupied modes.

2. During occupied modes the outside air damper shall never be positioned below the scheduled “standard occupancy minimum outdoor air” quantity (O.A. damper occupied minimum position) except in case of alarm.
3. Provide provision for extended commissioning (one year) to check calibration of CO2 sensor, monitor/test CO2 levels to ensure target person ventilation rates are met and maintained and the lag time is within the limit prescribed by ASHRAE 62.
4. Note: CO2 sensors shall work with BMS to provide space CO2 level record keeping every 15 minutes for 3 years.
5. CO2 Concentration “Set Points”:
   a. CO2 concentration inside/outside differentials (set points) are listed for each AHU system. The listed set points are based on maintaining the inside/outside CO2 differential (specific to each individual system) at 100 ppm below its corresponding maximum occupancy at a metabolic rate of 1.2 MET.
   b. Note: Outside air CO2 concentration shall be measured.
6. Standard occupancy minimum outdoor air”: The minimum volumetric flow of outside air during occupied times when the space is minimally occupied (identified as the “standard occupancy minimum outdoor air”) has been calculated to be the greater of:
   a. Outside air required to satisfy the building area requirement in the Code,
   b. Outside air required to satisfy the makeup air requirement for transfer air to other spaces from the space(s) served by the AHU.
   c. Outside air required to provide twenty percent (20%) of the volumetric flow rate required for the maximum occupant load.
7. Equipment outside Air Damper Control:
   a. CO2 readings shall be compared to the CO2 set point. If the reading is less than 100 ppm above outside air CO2 level the BMS shall maintain the base ventilation rate at the scheduled “standard occupancy minimum outdoor air” quantity (O.A. damper occupied minimum position). If the CO2 reading rises 100 ppm above outside air CO2 concentration, then the BMS shall start to modulate the outside air dampers open utilizing a proportional-integral (PI) loop to reduce the CO2 concentration in the space. The outside air damper shall be open for full occupancy when the CO2 level reaches the set point. Once the space CO2 level drops below 100 ppm above outside air CO2 level the outside air dampers shall move to maintain the scheduled “standard occupancy minimum outdoor air” quantity (O.A. damper occupied minimum position).
   b. If the BMS determines that it is beneficial to use additional outside air for cooling, then it shall override the demand controlled ventilation algorithm to modulate the dampers to an increased open position as required.
   c. Start-up purge cycle:
      1) Set 30 minutes prior to occupied modes (adj.).
      2) When the unit starts the outdoor air damper shall open initiating a timed purge cycle. The outdoor air damper shall modulate to maintain the mixed airflow with outside air percentage at 100% of full occupancy load.
   d. Post purge cycle:
      1) Used prior to changing from occupied mode to unoccupied mode.
      2) System shall not change from occupied mode to unoccupied mode until space CO2 level drops to ambient level.

3.05 OPTIMAL START SEQUENCE

A. Optimal start mode-bringing the space up to temperature:
   1. Every 3 minutes the heating and cooling set points will be slowly adjusted from the unoccupied settings to the occupied settings throughout the optimal start time period.

2. The room set points will be held at their occupied settings for a period of time prior to occupancy in an effort to heat, or cool, the mass of the room (The furniture and other surfaces).
3. The fan will only start if the space temperature is below the heating set point or above the cooling set point as the set point values change.
4. The amount of time that the optimal start routine uses is based on the outside air temperature.
    a. More time is allotted as the outside air temperature becomes very cold or very warm
    b. Additional time is added for every day the room is unoccupied (up to 3 days).

3.06 DEMAND RESPONSIVE CONTROLS

A. Electric heating and cooling systems shall be provided with demand responsive controls capable of executing the following actions in response to a demand response signal:
    1. Automatically increase the zone operating cooling set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).
    2. Automatically decreasing the zone operating heating set point by the following values 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C) while maintaining the minimum room temperature requirements of Section 602.2 of the Property Maintenance Code of New York State.

B. Where a demand response signal is not present, the heating and cooling system controls shall be capable of performing all other functions. Where thermostats are controlled by direct digital control including, but not limited to, an energy management system, the system shall be capable of demand responsive control and capable of adjusting all thermal set-points to comply.

3.07 PROJECT SPECIFIC EQUIPMENT

A. **DOAS Units 1-11 (Displacement and Chilled Beam Terminal Units)**
    1. Rooftop mounted DOAS unit(s) consisting of one (1) supply fan, one (1) exhaust fan, one (1) energy recovery wheel, motorized outdoor air damper, barometric exhaust air damper, direct expansion (DX) heating/cooling coils (compressor heat pump system), and a hot gas reheat coil.
    2. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
        a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
    3. Occupied Mode:
        a. Determined by the BMS building time clock system.
        b. The BMS will start the unit supply and exhaust fans. The fans will be energized continuously whenever any of the served zones are scheduled to be occupied.
        c. The outside air dampers shall open fully to provide the airflow indicated on the Dedicated Outdoor Air System schedule.
        d. The BMS will monitor the discharge air temperature and control heating/cooling operation.
        e. Occupied Cooling / Dehumidification:
            1) The primary source of sensible cooling shall be the room-level displacement ventilation or chilled beam terminal units. The DOAS cooling coil is the primary source of latent cooling.
            2) The DX compressors shall stage / modulate to maintain a space dew-point temperature (DPT) setpoint of 55 deg F (adj.). For systems serving multiple spaces, the cooling coil leaving air temperature shall be based on the space with the highest calculated DPT.
            3) Hot Gas Reheat
                (a) The hot gas reheat coil shall modulate to maintain a discharge air temperature of 60 deg F (adj.).

f. Occupied Heating:
   1) The DX compressors shall modulate to maintain a discharge air temperature setpoint of 60 deg F (adj.).
   2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the associated hydronic duct-mounted heating coil control valve shall modulate to maintain a discharge air temperature setpoint of 60 deg F (adj.). Refer to the "Hydronic Duct-Mounted Heating Coil" sequence below.

4. Unoccupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will disable the supply and exhaust fans. The outside air damper shall close, the mechanical cooling shall be disabled.
   c. The primary source of unoccupied cooling and heating shall be the room-level displacement ventilation or chilled beam terminal units. The associated DOAS unit shall be energized only if any connected space remains outside the unoccupied dew-point temperature setpoint for more than 30 minutes (adj.).
   d. Unoccupied Cooling:
      1) When the space dew-point temperature is above the unoccupied dew-point temperature setpoint of 59 deg. F (adj.) for more than 30 minutes (adj.) the supply fan shall be energized. The DX compressors shall stage / modulate to maintain a space dew-point temperature (DPT) setpoint of 59 deg F (adj.).
      2) When the space dew-point temperature falls below the unoccupied dew-point setpoint of 59 deg. F (adj.) the supply and exhaust fans shall be disabled, the outside air damper shall close, and the mechanical cooling shall be disabled.
5. Energy Recovery Wheel Control:
   a. The energy recovery wheel motor will be enabled whenever the supply and return/exhaust fans are enabled except as noted here:
      1) ERW Defrost Mode:
         (a) Occurs when the outdoor air temperature DB is below 0 deg. F (adj.), and 30 minutes (adj.) have elapsed since the last defrost mode.
         (b) Defrost mode shall slow the heat wheel motor for two minutes.
         (c) Before the heat wheel motor is disabled, a two minute delay will occur while the economizer closes to a 10% position to allow the return air to have maximum defrost effect on the wheel.
         (d) At the end of defrost mode, the heat wheel motor will enable, and the economizer will return to normal position.
      2) Economizer Mode
         (a) The BMS shall compare the enthalpy of the outside air and the return air. When the unit is in cooling / dehumidification mode, the BMS shall enter economizer mode if the outside air enthalpy is less than the exhaust air enthalpy.
         (b) In economizer mode, the outdoor air and exhaust air dampers shall open and the energy recovery wheel shall be deenergized.
         (c) When economizer mode is no longer required, the supply and exhaust bypass dampers shall close and the energy wheel shall be energized.
6. Safeties/Alarms:
   a. Reference and monitor all factory safeties.
   b. Compressor(s) Failure
   c. Supply Fan Failure:
      1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.

d. Exhaust Fan Failure:
   1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
e. Energy Recovery Wheel VFD Fault:
   1) If the ERW motor is enabled and the VFD status is off for more than 30 seconds (adj.), the BMS shall alarm.
f. Dirty Filter Alarm:
   1) Differential pressure switch is used to indicate a dirty filter status. Differential pressure setting shall be adjustable.
g. Drain Pan High-Level Alarm
h. A2L Refrigerant Leak Alarm
   1) If the factory installed refrigerant leak detection sensor and control board detects refrigerant concentration above 25% of the ASHRAE Std. 34 listed Lower Flammability Limit (LFL), the outdoor unit compressors shall be commanded off and the unit supply fans shall be commanded on at 100% capacity. Once the refrigerant concentration falls below 25% of the LFL, maintain fan speeds for 5 additional minutes. Unit will remain in a hard lockout until manually reset.
i. Discharge Air Temperature High Limit:
   1) If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.
j. Discharge air temperature low limit:
   1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.
k. Outside Air Damper Failure:
   1) If the unit is enabled in occupied mode, and the outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm

7. Monitor and Trend:
   a. Supply Air Temperature
   b. Supply Air Humidity
   c. Supply Fan Status
   d. Return Air Temperature
   e. Return Air Humidity
   f. Exhaust Fan Status
   g. Outside Air Airflow
   h. Outdoor Air Temperature
   i. Outdoor Air Humidity
   j. Outdoor Air Dew Point
   k. Outdoor Air Damper Status
   l. Energy Recovery Wheel Discharge Air Temperature
   m. Energy Recovery Wheel Status

B. **DOAS Unit 12 (Energy Recovery Plate DOAS Units Serving Fan Coil Units)**
1. Rooftop mounted DOAS unit consisting of one (1) supply fan, one (1) exhaust fan, one (1) energy recovery plate, motorized outdoor air damper, barometric exhaust air damper, direct expansion (DX) heating/cooling coils (compressor heat pump system), and a hot gas reheat coil.
2. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
   a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
3. Occupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will start the unit supply and exhaust fans. The fans will be energized continuously whenever any of the served zones are scheduled to be occupied.

c. The outside air dampers shall open fully to provide the airflow indicated on the Dedicated Outdoor Air System schedule.
d. The BMS will monitor the discharge air temperature and control heating/cooling operation.
e. Occupied Cooling:
    1) The primary source of sensible cooling shall be the room-level DX fan coil units units.
    2) The DX compressors shall stage / modulate to maintain a unit leaving air temperature setpoint of 75 deg F (adj.).
    3) Hot Gas Reheat
        (a) The hot gas reheat coil shall modulate to maintain a discharge air temperature of 70 deg F (adj.).
f. Occupied Heating:
    1) The DX compressors shall modulate to maintain a discharge air temperature setpoint of 70 deg F (adj.).

4. Unoccupied Mode:
    a. Determined by the BMS building time clock system.
    b. The BMS will disable the supply and exhaust fans. The outside air damper shall close, the mechanical cooling shall be disabled.
    c. The primary source of unoccupied cooling and heating shall be the room-level DX fan coil
5. Fixed Plate Exchanger Control:
    a. Defrost Mode:
        1) Occurs when the outdoor air temperature DB is below 0 deg. F (adj.), and 30 minutes (adj.) have elapsed since the last defrost mode.
        2) OA bypass damper opens, OA damper closes. Warm RA is sent through plate exchanger.
        3) At the end of defrost mode, the OA bypass damper will close and the OA damper will open.
    b. Economizer Mode
        1) The BMS shall compare the enthalpy of the outside air and the return air. When the unit is in cooling mode, the BMS shall enter economizer mode if the outside air enthalpy is less than the exhaust air enthalpy.
        2) In economizer mode, the bypass outdoor air damper shall open. The outdoor air damper shall close, and outdoor air will bypass the plate exchanger.
        3) When economizer mode is no longer required, the bypass outdoor air damper shall close. The outdoor air damper shall open, and outdoor air will be sent through the plate exchanger
6. Safeties/Alarms:
    a. Reference and monitor all factory safeties.
    b. Compressor(s) Failure
    c. Supply Fan Failure:
        1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
    d. Exhaust Fan Failure:
        1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
    e. Dirty Filter Alarm:
        1) Differential pressure switch is used to indicate a dirty filter status. Differential pressure setting shall be adjustable.
    f. Drain Pan High-Level Alarm

g. A2L Refrigerant Leak Alarm
   1) If the factory installed refrigerant leak detection sensor and control board detects refrigerant concentration above 25% of the ASHRAE Std. 34 listed Lower Flammability Limit (LFL), the outdoor unit compressors shall be commanded off and the unit supply fans shall be commanded on at 100% capacity. Once the refrigerant concentration falls below 25% of the LFL, maintain fan speeds for 5 additional minutes. Unit will remain in a hard lockout until manually reset.

h. Discharge Air Temperature High Limit:
   1) If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.

i. Discharge air temperature low limit:
   1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.

j. Outside Air Damper Failure:
   1) If the unit is enabled in occupied mode, and the outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm

k. Bypass Outside Air Damper Failure:
   1) If the unit bypass outdoor air damper is enabled in defrost or economizer mode, and the bypass outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm

7. Monitor and Trend:
   a. Supply Air Temperature
   b. Supply Air Humidity
   c. Supply Fan Status
   d. Return Air Temperature
   e. Return Air Humidity
   f. Exhaust Fan Status
   g. Outside Air Airflow
   h. Outdoor Air Temperature
   i. Outdoor Air Humidity
   j. Outdoor Air Dew Point
   k. Outdoor Air Damper Status
   l. Bypass Outdoor Air Damper Status
   m. Plate Exchanger Discharge Air Temperature

C. **DOAS Units 13-14 (ERW DOAS Units Serving Fan Coil Units)**
1. Rooftop mounted DOAS unit(s) consisting of one (1) supply fan, one (1) exhaust fan, one (1) energy recovery wheel, motorized outdoor air damper, barometric exhaust air damper, direct expansion (DX) heating/cooling coils (compressor heat pump system), and a hot gas reheat coil.
2. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
   a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
3. Occupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will start the unit supply and exhaust fans. The fans will be energized continuously whenever any of the served zones are scheduled to be occupied.
   c. The outside air dampers shall open fully to provide the airflow indicated on the Dedicated Outdoor Air System schedule.
   d. The BMS will monitor the discharge air temperature and control heating/cooling operation.
   e. Occupied Cooling / Dehumidification:
      1) The primary source of sensible cooling shall be the room-level fan coil units. The DOAS cooling coil is the primary source of latent cooling.

2) The DX compressors shall stage / modulate to maintain a space dew-point temperature (DPT) setpoint of 55 deg F (adj.). For systems serving multiple spaces, the cooling coil leaving air temperature shall be based on the space with the highest calculated DPT.
3) Hot Gas Reheat
(a) The hot gas reheat coil shall modulate to maintain a discharge air temperature of 70 deg F (adj.).

f. Occupied Heating:
1) The DX compressors shall modulate to maintain a discharge air temperature setpoint of 70 deg F (adj.).
2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the associated hydronic duct-mounted heating coil control valve shall modulate to maintain a discharge air temperature setpoint of 60 deg F (adj.). Refer to the "Hydronic Duct-Mounted Heating Coil" sequence below.

4. Unoccupied Mode:
a. Determined by the BMS building time clock system.
b. The BMS will disable the supply and exhaust fans. The outside air damper shall close, the mechanical cooling shall be disabled.
c. The primary source of unoccupied cooling and heating shall be the room-level fan coil units.

5. Energy Recovery Wheel Control:
a. The energy recovery wheel motor will be enabled whenever the supply and return/exhaust fans are enabled except as noted here:
1) ERW Defrost Mode:
(a) Occurs when the outdoor air temperature DB is below 0 deg. F (adj.), and 30 minutes (adj.) have elapsed since the last defrost mode.
(b) Defrost mode shall slow the heat wheel motor for two minutes.
(c) Before the heat wheel motor is disabled, a two minute delay will occur while the economizer closes to a 10% position to allow the return air to have maximum defrost effect on the wheel.
(d) At the end of defrost mode, the heat wheel motor will enable, and the economizer will return to normal position.
2) Economizer Mode
(a) The BMS shall compare the enthalpy of the outside air and the return air. When the unit is in cooling / dehumidification mode, the BMS shall enter economizer mode if the outside air enthalpy is less than the exhaust air enthalpy.
(b) In economizer mode, the outdoor air and exhaust air dampers shall open and the energy recovery wheel shall be deenergized.
(c) When economizer mode is no longer required, the supply and exhaust bypass dampers shall close and the energy wheel shall be energized.

6. Safeties/Alarms:
a. Reference and monitor all factory safeties.
b. Compressor(s) Failure
c. Supply Fan Failure:
1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
d. Exhaust Fan Failure:
1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.

e. Energy Recovery Wheel VFD Fault:
   1) If the ERW motor is enabled and the VFD status is off for more than 30 seconds (adj.), the BMS shall alarm.
f. Dirty Filter Alarm:
   1) Differential pressure switch is used to indicate a dirty filter status. Differential pressure setting shall be adjustable.
g. Drain Pan High-Level Alarm
h. A2L Refrigerant Leak Alarm
   1) If the factory installed refrigerant leak detection sensor and control board detects refrigerant concentration above 25% of the ASHRAE Std. 34 listed Lower Flammability Limit (LFL), the outdoor unit compressors shall be commanded off and the unit supply fans shall be commanded on at 100% capacity. Once the refrigerant concentration falls below 25% of the LFL, maintain fan speeds for 5 additional minutes. Unit will remain in a hard lockout until manually reset.
i. Discharge Air Temperature High Limit:
   1) If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.
j. Discharge air temperature low limit:
   1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.
k. Outside Air Damper Failure:
   1) If the unit is enabled in occupied mode, and the outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm
l. Bypass Outside Air Damper Failure:
   1) If the unit bypass outdoor air damper is enabled in defrost or economizer mode, and the bypass outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm

7. Monitor and Trend:
   a. Supply Air Temperature
   b. Supply Air Humidity
   c. Supply Fan Status
   d. Return Air Temperature
   e. Return Air Humidity
   f. Exhaust Fan Status
   g. Outside Air Airflow
   h. Outdoor Air Temperature
   i. Outdoor Air Humidity
   j. Energy Recovery Wheel Status
   k. Outdoor Air Dew Point
   l. Outdoor Air Damper Status
   m. Energy Recovery Wheel Discharge Air Temperature
   n. Energy Recovery Wheel Status

D. **DOAS Unit 15 (FACS Classroom)**
1. Rooftop mounted DOAS unit consisting of one (1) supply fan, one (1) exhaust fan, one (1) energy recovery wheel, modulating mixed air damper, barometric exhaust air damper, direct expansion (DX) heating/cooling coils (compressor heat pump system), hot gas reheat coil, and an auxiliary natural gas heating coil with modulating control valve.
2. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
   a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
3. Demand Responsive Controls: Refer to "Demand responsive controls" sequence above.
4. Occupied Mode:
   a. Determined by the BMS building time clock system.

b. The BMS will start the unit supply and exhaust fans. The fans will be energized continuously whenever any of the served zones are scheduled to be occupied.
c. The BMS will monitor the zone temperature and control heating/cooling operation.
d. Normal Operation:
    1) The mixed air damper shall modulate to provide 880 CFM of outdoor air.
    2) Cooling:
        (a) The DX compressors shall stage / modulate to maintain a space temperature setpoint of 75 deg F (adj.).
        (b) Maintain space humidity below 70% RH (adj.) utilizing hot gas reheat.
    3) Heating:
        (a) The DX compressors shall stage / modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
        (b) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the associated hydronic duct-mounted heating coil control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.). Refer to the "Hydronic Duct-Mounted Heating Coil" sequence below.
e. Exhaust Hood Operation:
    1) The mixed air damper shall modulate to provide 1400 CFM of outdoor air.
    2) Cooling:
        (a) The DX compressors shall stage / modulate to maintain a space temperature setpoint of 75 deg F (adj.).
        (b) Maintain space humidity below 70% RH (adj.) utilizing hot gas reheat.
    3) Heating:
        (a) The DX compressors shall stage / modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
        (b) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the associated hydronic duct-mounted heating coil control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.). Refer to the "Hydronic Duct-Mounted Heating Coil" sequence below.

5. Unoccupied Mode:
    a. Determined by the BMS building time clock system.
    b. The BMS will disable the supply and exhaust fans. The mixed air damper shall close, the mechanical cooling shall be disabled.
    c. Unoccupied Cooling:
        1) The supply fan shall be energized and the mixed air damper shall be set for 100% recirculation. The DX compressors shall stage / modulate to maintain a space temperature setpoint of 85 deg F (adj.).
    d. Unoccupied Heating:
        1) The supply fan shall be energized and the mixed air damper shall be set for 100% recirculation. The DX compressors shall stage / modulate to maintain a space temperature setpoint of 60 deg F (adj.).
        2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the associated hydronic duct-mounted heating coil control valve shall modulate to maintain a zone temperature setpoint of 60 deg F (adj.). Refer to the "Hydronic Duct-Mounted Heating Coil" sequence below.
6. Energy Recovery Wheel Control:

a. The energy recovery wheel motor will be enabled whenever the supply and return/exhaust fans are enabled except as noted here:
    1) ERW Defrost Mode:
        (a) Occurs when the outdoor air temperature DB is below 0 deg. F (adj.), and 30 minutes (adj.) have elapsed since the last defrost mode.
        (b) Defrost mode shall slow the heat wheel motor for two minutes.
        (c) Before the heat wheel motor is disabled, a two minute delay will occur while the economizer closes to a 10% position to allow the return air to have maximum defrost effect on the wheel.
        (d) At the end of defrost mode, the heat wheel motor will enable, and the economizer will return to normal position.
    2) Economizer Mode
        (a) The BMS shall compare the enthalpy of the outside air and the return air. When the unit is in occupied cooling mode, the BMS shall enter economizer mode if the outside air enthalpy is less than the exhaust air enthalpy.
        (b) In economizer mode, the outdoor air and exhaust air dampers shall open and the energy recovery wheel shall be deenergized.
        (c) When economizer mode is no longer required, the supply and exhaust bypass dampers shall close and the energy wheel shall be energized.

7. Safeties/Alarms:
    a. Reference and monitor all factory safeties.
    b. Compressor(s) Failure
    c. Supply Fan Failure:
        1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
    d. Exhaust Fan Failure:
        1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
    e. Energy Recovery Wheel VFD Fault:
        1) If the ERW motor is enabled and the VFD status is off for more than 30 seconds (adj.), the BMS shall alarm.
    f. Dirty Filter Alarm:
        1) Differential pressure switch is used to indicate a dirty filter status. Differential pressure setting shall be adjustable.
    g. Drain Pan High-Level Alarm
    h. A2L Refrigerant Leak Alarm
        1) If the factory installed refrigerant leak detection sensor and control board detects refrigerant concentration above 25% of the ASHRAE Std. 34 listed Lower Flammability Limit (LFL), the outdoor unit compressors shall be commanded off and the unit supply fans shall be commanded on at 100% capacity. Once the refrigerant concentration falls below 25% of the LFL, maintain fan speeds for 5 additional minutes. Unit will remain in a hard lockout until manually reset.
    i. Discharge Air Temperature High Limit:
        1) If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.
    j. Discharge air temperature low limit:
        1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.
    k. Outside Air Damper Failure:
        1) If the unit is enabled in occupied mode, and the outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm

8. Monitor and Trend:
    a. Supply Air Temperature
    b. Supply Air Humidity
    c. Supply Fan Status
    d. Return Air Temperature
    e. Return Air Humidity
    f. Exhaust Fan Status
    g. Outside Air Airflow
    h. Outdoor Air Temperature
    i. Outdoor Air Humidity
    j. Outdoor Air Dew Point
    k. Energy Recovery Wheel Discharge Air Temperature
    l. Energy Recovery Wheel Status
    m. Mixed Air Damper Status
    n. Gas Heating Coil Input

E. **Rooftop Units 1, 2 (Gymnasium) & 3 (Auditorium)**
1. Rooftop units consisting of various supply fans (see schedule for count), various exhaust fans (see schedule for count), one (1) energy recovery wheel, modulating mixed air damper, barometric exhaust air damper, direct expansion (DX) heating/cooling coils (compressor heat pump system), hot gas reheat coil, and an auxiliary natural gas heating coil with modulating control valve.
2. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
    a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
3. Demand Responsive Controls: Refer to "Demand responsive controls" sequence above.
4. Occupied Mode:
    a. Determined by the BMS building time clock system.
    b. The BMS will start the unit supply and exhaust fans. The fans will be energized continuously whenever any of the served zones are scheduled to be occupied.
    c. The BMS will monitor the zone temperature and control heating/cooling operation.
    d. Demand Ventilation Control
        1) CO2 readings shall be compared to the CO2 concentration control set point. The CO2 concentration control setpoint of RTU-1 shall be 635 ppm. The CO2 concentration control setpoint of RTU-2 shall be 671 ppm. The CO2 concentration control setpoint of RTU-3 shall be 1473 ppm. If the CO2 reading is less than 100 ppm above outside air CO2 level, the DDC system shall maintain the base ventilation rate at the scheduled “standard minimum outdoor air” quantity. If the CO2 reading rises 100 ppm above outside air CO2 concentration, then the DDC system shall start to modulate the outside air dampers open utilizing a proportional-integral (PI) loop to reduce the CO2 concentration in the space. The outside air damper shall be open for full occupancy when the CO2 level reaches the set point. Once the space CO2 level drops below 100 ppm above outside air CO2 level the outside air dampers shall move to maintain the scheduled “standard minimum outdoor air” quantity.
    e. Economizer Mode:
        1) The BMS shall compare the enthalpy of the outside air and the return air. When the unit is in occupied cooling mode, the BMS shall enter economizer mode if the outside air enthalpy is less than the exhaust air enthalpy.
        2) Energy recovery wheel - In economizer mode, the outdoor air and exhaust air dampers shall open and the energy recovery wheel shall be deenergized.
        3) Economizer relief shall be accomplished with associated gravity relief ventilators.

(a) RTU-1: GR-1 & GR-2
(b) RTU-2: GR-3 & GR-4
(c) RTU-3: GR-5, GR-6 & GR-7

4) On a call for economizer cooling, command the gravity relief ventilator exhaust air dampers open.
5) When economizer mode is no longer required, the gravity relief ventilator exhaust air dampers shall be closed.
6) Energy recovery wheel - When economizer mode is no longer required, the supply and exhaust bypass dampers shall close and the energy wheel shall be energized.

f. Cooling:
1) The DX compressors shall stage / modulate to maintain a space temperature setpoint of 75 deg F (adj.).
2) Maintain space humidity below 70% RH (adj.) utilizing hot gas reheat.

g. Heating:
1) The DX compressors shall stage / modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the auxiliary natural gas heating coil control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).

h. Post Occupancy Purge: Refer to "Post Occupancy Purge" Sequence above.

5. Unoccupied Mode:
a. Determined by the BMS building time clock system.
b. The BMS will disable the supply and exhaust fans. The mixed air damper shall close, the mechanical cooling shall be disabled.
c. Unoccupied Cooling:
1) The supply fan shall be energized and the mixed air damper shall be set for 100% recirculation. The DX compressors shall stage / modulate to maintain a space temperature setpoint of 85 deg F (adj.).
d. Unoccupied Heating:
1) The supply fan shall be energized and the mixed air damper shall be set for 100% recirculation. The DX compressors shall stage / modulate to maintain a space temperature setpoint of 60 deg F (adj.).
2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the auxiliary natural gas heating coil control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).

6. Energy Recovery Wheel Control:
a. The energy recovery wheel motor will be enabled whenever the supply and return/exhaust fans are enabled except as noted here:
1) ERW Defrost Mode:
(a) Occurs when the outdoor air temperature DB is below 0 deg. F (adj.), and 30 minutes (adj.) have elapsed since the last defrost mode.
(b) Defrost mode shall slow the heat wheel motor for two minutes.
(c) Before the heat wheel motor is disabled, a two minute delay will occur while the economizer closes to a 10% position to allow the return air to have maximum defrost effect on the wheel.
(d) At the end of defrost mode, the heat wheel motor will enable, and the economizer will return to normal position.

7. Safeties/Alarms:
a. Reference and monitor all factory safeties.
b. Compressor(s) Failure

c. Supply Fan Failure:
   1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
d. Exhaust Fan Failure:
   1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
e. Energy Recovery Wheel VFD Fault:
   1) If the ERW motor is enabled and the VFD status is off for more than 30 seconds (adj.), the BMS shall alarm.
f. Dirty Filter Alarm:
   1) Differential pressure switch is used to indicate a dirty filter status. Differential pressure setting shall be adjustable.
g. Drain Pan High-Level Alarm
h. A2L Refrigerant Leak Alarm
   1) If the factory installed refrigerant leak detection sensor and control board detects refrigerant concentration above 25% of the ASHRAE Std. 34 listed Lower Flammability Limit (LFL), the outdoor unit compressors shall be commanded off and the unit supply fans shall be commanded on at 100% capacity. Once the refrigerant concentration falls below 25% of the LFL, maintain fan speeds for 5 additional minutes. Unit will remain in a hard lockout until manually reset.
i. Discharge Air Temperature High Limit:
   1) If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.
j. Discharge air temperature low limit:
   1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.
k. Outside Air Damper Failure:
   1) If the unit is enabled in occupied mode, and the outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm

8. Monitor and Trend:
   a. Supply Air Temperature
   b. Supply Air Humidity
   c. Supply Fan Status
   d. Return Air Temperature
   e. Return Air Humidity
   f. Exhaust Fan Status
   g. Outside Air Airflow
   h. Outdoor Air Temperature
   i. Outdoor Air Humidity
   j. Outdoor Air Dew Point
   k. Energy Recovery Wheel Discharge Air Temperature
   l. Energy Recovery Wheel Status
   m. Mixed Air Damper Status
   n. Gas Heating Coil Input
   o. Space Temperature
   p. Space Humidity
   q. Space CO2

F. **Rooftop Unit 4 (Library)**
   1. Rooftop unit consisting of one (1) supply fan, one (1) exhaust fan, modulating mixed air damper, barometric exhaust air damper, direct expansion (DX) heating/cooling coils (compressor heat pump system), hot gas reheat coil, and an auxiliary natural gas heating coil with modulating control valve.

2. Demand Responsive Controls: Refer to "Demand responsive controls" sequence above.
3. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
    a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
4. Occupied Mode:
    a. Determined by the BMS building time clock system.
    b. The BMS will start the unit supply and exhaust fans. The fans will be energized continuously whenever any of the served zones are scheduled to be occupied.
    c. The BMS will monitor the zone temperature and control heating/cooling operation.
    d. Cooling:
        1) The DX compressors shall stage / modulate to maintain a space temperature setpoint of 75 deg F (adj.).
        2) Maintain space humidity below 70% RH (adj.) utilizing hot gas reheat.
    e. Heating:
        1) The DX compressors shall stage / modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
        2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the auxiliary natural gas heating coil control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
    f. Post Occupancy Purge: Refer to "Post Occupancy Purge" Sequence above.
5. Unoccupied Mode:
    a. Determined by the BMS building time clock system.
    b. The BMS will disable the supply and exhaust fans. The mixed air damper shall close, the mechanical cooling shall be disabled.
    c. Unoccupied Cooling:
        1) The supply fan shall be energized and the mixed air damper shall be set for 100% recirculation. The DX compressors shall stage / modulate to maintain a space temperature setpoint of 85 deg F (adj.).
    d. Unoccupied Heating:
        1) The supply fan shall be energized and the mixed air damper shall be set for 100% recirculation. The DX compressors shall stage / modulate to maintain a space temperature setpoint of 60 deg F (adj.).
        2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the auxiliary natural gas heating coil control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
6. Safeties/Alarms:
    a. Reference and monitor all factory safeties.
    b. Compressor(s) Failure
    c. Supply Fan Failure:
        1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
    d. Exhaust Fan Failure:
        1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
    e. Dirty Filter Alarm:
        1) Differential pressure switch is used to indicate a dirty filter status. Differential pressure setting shall be adjustable.
    f. Drain Pan High-Level Alarm
    g. A2L Refrigerant Leak Alarm
        1) If the factory installed refrigerant leak detection sensor and control board detects refrigerant concentration above 25% of the ASHRAE Std. 34 listed Lower Flammability Limit (LFL), the outdoor unit compressors shall be commanded off

and the unit supply fans shall be commanded on at 100% capacity. Once the refrigerant concentration falls below 25% of the LFL, maintain fan speeds for 5 additional minutes. Unit will remain in a hard lockout until manually reset.

h. Discharge Air Temperature High Limit:
   1) If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.
i. Discharge air temperature low limit:
   1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.
   2) If the unit is enabled in occupied mode, and the outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm

7. Monitor and Trend:
   a. Supply Air Temperature
   b. Supply Air Humidity
   c. Supply Fan Status
   d. Return Air Temperature
   e. Return Air Humidity
   f. Exhaust Fan Status
   g. Outside Air Airflow
   h. Outdoor Air Temperature
   i. Outdoor Air Humidity
   j. Outdoor Air Dew Point
   k. Mixed Air Damper Status
   l. Gas Heating Coil Input
   m. Space Temperature
   n. Space Humidity

G. **Rooftop Unit 5 (Kitchen)**
1. Rooftop unit consisting of two (2) supply fans, two (2) exhaust fans, one (1) energy recovery wheel, modulating mixed air damper, barometric exhaust air damper, direct expansion (DX) heating/cooling coils (compressor heat pump system), hot gas reheat coil, and an auxiliary natural gas heating coil with modulating control valve.
2. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
   a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
3. Demand Responsive Controls: Refer to "Demand responsive controls" sequence above.
4. Occupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will start the unit supply and exhaust fans. The fans will be energized continuously whenever any of the served zones are scheduled to be occupied.
   c. The BMS will monitor the zone temperature and control heating/cooling operation.
   d. Demand Ventilation Control
      1) CO2 readings shall be compared to the CO2 concentration control set point. The CO2 concentration control setpoint of RTU-5 shall be 939 ppm. If the CO2 reading is less than 100 ppm above outside air CO2 level, the DDC system shall maintain the base ventilation rate at the scheduled “standard minimum outdoor air” quantity. If the CO2 reading rises 100 ppm above outside air CO2 concentration, then the DDC system shall start to modulate the outside air dampers open utilizing a proportional-integral (PI) loop to reduce the CO2 concentration in the space. The outside air damper shall be open for full occupancy when the CO2 level reaches the set point. Once the space CO2 level drops below 100 ppm above outside air CO2 level the outside air dampers shall move to maintain the scheduled “standard minimum outdoor air” quantity.
   e. Cooling:

1) The DX compressors shall stage / modulate to maintain a space temperature setpoint of 75 deg F (adj.).
2) Maintain space humidity below 70% RH (adj.) utilizing hot gas reheat.

f. Heating:
1) The DX compressors shall stage / modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the auxiliary natural gas heating coil control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).

g. Exhaust Fan Control:
1) The two (2) unit exhaust fans shall control the pressure differential between 105 - Kitchen/Kitchen Storage and 104 - Cafeteria/Study Hall. The cafeteria, where the RTU return ductwork is located, shall maintain a +0.05" IN. W.G. (adj.) pressure differential with the kitchen.

h. Post Occupancy Purge: Refer to "Post Occupancy Purge" Sequence above.

5. Unoccupied Mode:
a. Determined by the BMS building time clock system.
b. The BMS will disable the supply and exhaust fans. The mixed air damper shall close, the mechanical cooling shall be disabled.
c. Unoccupied Cooling:
1) The supply fan(s) shall be energized and the mixed air damper shall be set for 100% recirculation. The DX compressors shall stage / modulate to maintain a space temperature setpoint of 85 deg F (adj.).

d. Unoccupied Heating:
1) The supply fan(s) shall be energized and the mixed air damper shall be set for 100% recirculation. The DX compressors shall stage / modulate to maintain a space temperature setpoint of 60 deg F (adj.).
2) If the DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the auxiliary natural gas heating coil control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).

6. Energy Recovery Wheel Control:
a. The energy recovery wheel motor will be enabled whenever the supply and return/exhaust fans are enabled except as noted here:
1) ERW Defrost Mode:
(a) Occurs when the outdoor air temperature DB is below 0 deg. F (adj.), and 30 minutes (adj.) have elapsed since the last defrost mode.
(b) Defrost mode shall slow the heat wheel motor for two minutes.
(c) Before the heat wheel motor is disabled, a two minute delay will occur while the economizer closes to a 10% position to allow the return air to have maximum defrost effect on the wheel.
(d) At the end of defrost mode, the heat wheel motor will enable, and the economizer will return to normal position.
2) Economizer Mode
(a) The BMS shall compare the enthalpy of the outside air and the return air. When the unit is in occupied cooling mode, the BMS shall enter economizer mode if the outside air enthalpy is less than the exhaust air enthalpy.
(b) In economizer mode, the outdoor air and exhaust air dampers shall open and the energy recovery wheel shall be deenergized.
(c) When economizer mode is no longer required, the supply and exhaust bypass dampers shall close and the energy wheel shall be energized.

7. Safeties/Alarms:
a. Reference and monitor all factory safeties.

b. Compressor(s) Failure
c. Supply Fan Failure:
    1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
d. Exhaust Fan Failure:
    1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
e. Energy Recovery Wheel VFD Fault:
    1) If the ERW motor is enabled and the VFD status is off for more than 30 seconds (adj.), the BMS shall alarm.
f. Dirty Filter Alarm:
    1) Differential pressure switch is used to indicate a dirty filter status. Differential pressure setting shall be adjustable.
g. Drain Pan High-Level Alarm
h. A2L Refrigerant Leak Alarm
    1) If the factory installed refrigerant leak detection sensor and control board detects refrigerant concentration above 25% of the ASHRAE Std. 34 listed Lower Flammability Limit (LFL), the outdoor unit compressors shall be commanded off and the unit supply fans shall be commanded on at 100% capacity. Once the refrigerant concentration falls below 25% of the LFL, maintain fan speeds for 5 additional minutes. Unit will remain in a hard lockout until manually reset.
i. Discharge Air Temperature High Limit:
    1) If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.
j. Discharge air temperature low limit:
    1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.
k. Outside Air Damper Failure:
    1) If the unit is enabled in occupied mode, and the outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm
l. Pressurization Low Limit:
    1) If the pressure differential between the cafeteria and kitchen falls below -0.02 IN. W.G. (adj.), the BMS shall alarm.

8. Monitor and Trend:
    a. Supply Air Temperature
    b. Supply Air Humidity
    c. Supply Fan Status
    d. Return Air Temperature
    e. Return Air Humidity
    f. Exhaust Fan Status
    g. Outside Air Airflow
    h. Outdoor Air Temperature
    i. Outdoor Air Humidity
    j. Outdoor Air Dew Point
    k. Energy Recovery Wheel Discharge Air Temperature
    l. Energy Recovery Wheel Status
    m. Mixed Air Damper Status
    n. Gas Heating Coil Input
    o. Space Temperature
    p. Space Humidity
    q. Space CO2
    r. Cafeteria/Kitchen Pressure Differential

H. **Fan Coil Units 1-25 (DX or Chilled Water Cooling)**
1. Fan coil units include a supply fan, a heating hot water coil with modulating 2-way control valve, a DX or chilled water cooling coil with modulating 2-way control valve, and a two-position mixed air damper. Units with the DX cooling coil are connected to, and associated with a split air cooled condensing unit.
2. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
   a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
3. Demand Responsive Controls: Refer to "Demand responsive controls" sequence above.
4. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
5. Occupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will start the unit supply fan(s). The fan(s) will be energized continuously whenever the zone is scheduled to be occupied.
   c. The outside air damper shall open to provide a fixed percentage outside air ventilation anytime the unit is in occupied mode. The damper open position shall be set during testing and balancing.
   d. The BMS will monitor the zone temperature and control heating/cooling operation.
   e. Occupied Cooling:
      1) The primary source of latent cooling shall be associated DOAS unit(s). The fan coil unit cooling coil is the primary source of sensible cooling.
         (a) Exemption: Fan coil units with DX cooling coils
      2) Fan coil units with DX cooling:
         (a) The DX cooling coil shall maintain a zone temperature setpoint of 75 deg F (adj.).
      3) Fan coil units with chilled water cooling:
         (a) The chilled water control valve shall modulate to maintain a zone temperature setpoint of 75 deg F (adj.).
   f. Occupied Heating:
      1) The hot water control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
6. Unoccupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will disable the supply fan(s) and the outside air damper shall close.
   c. Unoccupied Cooling:
      1) Fan coil units with DX cooling:
         (a) The DX cooling coil shall maintain a zone temperature setpoint of 85 deg F (adj.).
      2) Fan coil units with chilled water cooling:
         (a) The chilled water control valve shall modulate to maintain a zone temperature setpoint of 85 deg F (adj.).
   d. Unoccupied Heating:
      1) The hot water control valve shall modulate to maintain a zone temperature setpoint of 60 deg F (adj.).
7. Safeties/Alarms:
   a. Compressor(s) Failure
      1) For DX coil units only.
   b. Supply Fan Failure:

1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.

c. Drain Pan High-Level Alarm

d. A2L Refrigerant Leak Alarm
   1) For DX coil units only.
   2) If the factory installed refrigerant leak detection sensor and control board detects refrigerant concentration above 25% of the ASHRAE Std. 34 listed Lower Flammability Limit (LFL), the outdoor unit compressors shall be commanded off and the unit supply fans shall be commanded on at 100% capacity. Once the refrigerant concentration falls below 25% of the LFL, maintain fan speeds for 5 additional minutes. Unit will remain in a hard lockout until manually reset.

e. Discharge Air Temperature High Limit:
   1) If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.

f. Discharge Air Temperature Low Limit:
   1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.

g. Zone Temperature High Limit
   1) If the zone temperature exceeds 85 deg F (adj.), the BMS shall alarm.

h. Zone Temperature Low Limit
   1) If the zone temperature is less than 55 deg F (adj.), the BMS shall alarm.

i. Outside Air Damper Failure:
   1) If the unit is enabled in occupied mode, and the outdoor air damper is not proven open for more than 30 seconds (adj.), the BMS shall alarm

8. Monitor and Trend:
   a. Supply Air Temperature
   b. Zone Temperature
   c. Supply Fan Status
   d. Zone Unoccupied Override
   e. Outdoor Air Damper Status

I. **Single-Zone Ductless Split Systems (SSI/SSO-1-8):**

1. Single zone ductless split systems are direct expansion heat pump, evaporator/condenser indoor units coupled with outdoor units. The units consist of a constant volume supply fan and a direct expansion heating/cooling coil.
2. System shall utilize factory controls. System shall operate continuously, and cooling/heating shall be initiated based on room temperature and set point:
   a. Heating setpoint: 70 deg F (adj.)
   b. Cooling setpoint: 75 deg F (adj.)
3. Alarms:
   a. High space temperature - BMS space temperature sensor. If space temperature exceeds 85 deg F (adj.), the BMS shall alarm.
   b. Low space temperature - BMS space temperature sensor. If space temperature is less than 55 deg F (adj.), the BMS shall alarm
   c. Drain pan overflow - If the drain pan level sensor is activated, the BMS shall alarm.

J. **Chilled Beam and Displacement Ventilation Terminal Units**

1. System consists of chilled beam or displacement ventilation units and (1) 6-way modulating control valve with associated condensation switch.
2. Occupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will monitor the zone temperature and control heating/cooling operation.
   c. Occupied Cooling:

1) The primary source of latent cooling shall be associated DOAS unit(s). The chilled beam or displacement ventilation unit cooling coil(s) are the primary source(s) of sensible cooling.
2) The chilled water control valve shall modulate to maintain a zone temperature setpoint of 75 deg F (adj.).

d. Occupied Heating:
1) The hot water control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).

3. Unoccupied Mode:
a. Determined by the BMS building time clock system.
b. Unoccupied Cooling:
1) The chilled water control valve shall modulate to maintain a zone temperature setpoint of 85 deg F (adj.).
c. Unoccupied Heating:
1) The hot water control valve shall modulate to maintain a zone temperature setpoint of 60 deg F (adj.).

4. Safeties/Alarms:
a. Zone Temperature High Limit
1) If the zone temperature exceeds 85 deg F (adj.), the BMS shall alarm.
b. Zone Temperature Low Limit
1) If the zone temperature is less than 55 deg F (adj.), the BMS shall alarm.
c. Condensation Alarm
1) When condensation is detected by the condensation switch located on the unit coil supply piping, the 6-way valve shall close and the BMS shall alarm.

5. Monitor and Trend:
a. Zone Temperature
b. Zone Humidity
c. Zone Dew Point

K. **Unit Heaters**

1. Cabinet unit heaters include a supply fan and an heating hot water coil with modulating 2-way control valve.
2. Optimal Start: Refer to "OPTIMAL START SEQUENCE" above.
a. Morning Warm-Up Mode: Refer to "Warm-Up Mode" sequence above.
3. Occupied Mode:
a. Determined by the BMS building time clock system.
b. The BMS will start the unit supply fan(s). The fan(s) will be energized continuously whenever the zone is scheduled to be occupied.
c. The BMS will monitor the zone temperature and control heating/cooling operation.
d. Occupied Heating:
1) The hot water control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).
e. Unit heaters within vesituble spaces:
1) The associated hot water control valve shall be disabled when the outdoor air temperature is greater than 45 deg F.
2) The hot water control valve shall modulate to maintain a zone temperature setpoint of 60 deg F (adj.).
f. Unit heater UH-3:
1) The hot water control valve shall modulate to maintain a zone temperature setpoint of 70 deg F (adj.).

2) If the assoicated overhead door between the mechanical room and exterior is opened for more than 5 minutes, disable mechanical heating to the zone or reset the space heating temperature setpoint to 55 deg F.

4. Unoccupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will disable the supply fan(s).
   c. Unoccupied Heating:
      1) The hot water control valve shall modulate to maintain a zone temperature setpoint of 60 deg F (adj.).
5. Safeties/Alarms:
   a. Supply Fan Failure:
      1) If the supply fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
   b. Zone Temperature High Limit
      1) If the zone temperature exceeds 90 deg F (adj.), the BMS shall alarm.
   c. Zone Temperature Low Limit
      1) If the zone temperature is less than 55 deg F (adj.), the BMS shall alarm.
6. Monitor and Trend:
   a. Zone Temperature
   b. Supply Fan Status
   c. Zone Unoccupied Override

L. **Duct Mounted Heating Coils**
1. Duct mounted heating coils include a heating hot water coil with modulating 2-way control valve.
2. Occupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will start the unit supply fan(s). The fan(s) will be energized continuously whenever the zone is scheduled to be occupied.
   c. The BMS will monitor the zone temperature and control heating/cooling operation.
   d. Occupied Heating:
      1) If the associated air supplying equipment's DX heating coil cannot maintain the heating setpoint or is locked out due to ambient temperature conditions, the hydronic duct-mounted heating coil control valve shall modulate to maintain a discharge air temperature setpoint of 60 deg F (adj.).
3. Unoccupied Mode:
   a. Determined by the BMS building time clock system.
   b. The BMS will disable the supply fan(s).
   c. Unoccupied Heating:
      1) The hot water control valve shall modulate to maintain a zone temperature setpoint of 60 deg F (adj.).
4. Safeties/Alarms:
   a. High discharge air temperature:If the discharge air temperature exceeds 120 deg F (adj.), the BMS shall alarm.
      1) If the discharge air temperature exceeds 80 deg F (adj.), the BMS shall alarm.
   b. Discharge air temperature low limit:
      1) If the discharge air temperature is less than 40 deg F (adj.), the BMS shall alarm.
5. Monitor and Trend:
   a. Discharge Air Temperature
   b. Control valve position

M. **Fume Hood Exhaust Fans (EFs 1-5 & 9)**
1. System includes (1) stack fume exhaust fan and (1) fume hood on/off switch installed on the fume hood.
2. Exhaust Fan Control:
   a. The exhaust fan shall be controlled by the local fume hood on/off switch. When the switch is in the on position, the interlocked exhaust air damper shall open, and the exhaust fan shall operate continuously.
3. Safeties/Alarms
   a. Fan Failure:
      1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
4. Monitor and Trend
   a. Exhaust Fan Status
   b. Exhaust Static Pressure

N. **Kitchen and Cafeteria Exhaust Fans (EFs 6 & 7, KEFs 1 & 2)**
1. System includes (2) general exhaust fans, EF-6 and EF-7, (2) kitchen hood exhaust fans, KEF-1 and KEF-2, and (1) rooftop unit, RTU-5.
2. Operating Modes:
   a. Refer to "Kitchen Air Balance and Control Schematic" for sequence of operations.
3. Safeties/Alarms:
   a. Fan Failure:
      1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
   b. Pressurization Alarm:
      1) If the pressurization between the cafeteria and kitchen is below -0.02 in. w.g. (adj.), the BMS shall alarm.
4. Monitor/Trend
   a. Exhaust Fan Status
   b. Pressurization
   c. EF-6 Airflow

O. **FACS Classroom Range Hood Exhaust Fan (EF-8)**
1. System includes one (1) exhaust fan and four (4) range hood on/off switches installed on the range hoods.
2. Exhaust Fan Control:
   a. The exhaust fan shall be controlled by the local range hood on/off switches. When any of the switches are in the on position, the exhaust fan shall operate continuously.
3. Safeties/Alarms
   a. Fan Failure:
      1) If the exhaust fan is enabled and the fan status is off for more than 30 seconds (adj.), the BMS shall alarm.
4. Monitor and Trend
   a. Exhaust Fan Status

P. **Destratification Fans**
1. System includes multiple destratification fans (See plans for counts), (1) controller per room, and (2) temperature/humidity sensors per room. One temperature/humidity sensor shall be considered the "Room" sensor installed at occupant height. The second sensor shall considered the "Ceiling" sensor installed above the destratification fan.
2. System shall be locally controlled.
3. Operating Modes:
   a. Summer Operation:

1) The system shall be enabled when the temperature measured by the Room sensor exceeds 75 deg F (adj.). The destratification fan shall automatically adjust fan speed to provide appropriate cooling.

b. Winter Operation:
1) The system shall be enabled when the differential temperature measured between the Room and Ceiling sensors exceeds 2 deg F (adj.). The destratification fan shall automatically adjust fan speed to de-stratify the space.

c. Manual Control:
1) The system shall have a manual override function. When in manual override, fan status and speed shall be adjustable.

Q. **Condensing Boilers (B 1-3) and Heating Hot Water Pumps (P 1-5)**

1. The boiler plant consists of (3) high-efficiency condensing boilers, (3) boiler circulation pumps, (2) building heating hot water loop pumps, and associated monitoring sensors.
2. Condensing Boiler Operation
   a. The boiler plant shall run on an Occupied/Unoccupied operation.
   b. The DDC system shall enable and disable the boilers based on a manual seasonal enable/disable software schedule.
   c. BMS shall provide proof of associated outdoor air damper end switch prior to enabling boiler.
   d. The boilers, when enabled for hot water production, shall be controlled by the boiler control package to maintain the hot water supply set point as set by the DDC system. The boiler loop shall maintain the following hot water temperature set point schedule:

O.A. Temp. (Deg F.)	Hot Water Supply Temp. (Deg F.)
0	140
60	100

   e. Utilize optimum start program to reach the above temperatures five-minutes prior to any building equipment warm-up modes or unoccupied mode.
   f. Provide manual override for building supply water temperature set point. Override shall be maintained for a period of 24-hours prior to automatically resuming reset schedule.
   g. Alarms:
      1) Boiler emergency shutdown
         (a) If the Boiler Emergency Shutdown Switch has been activated, the boilers are to shut down immediately and an alarm shall be signaled to the BMS workstation
      2) Boiler failure
      3) Low water cutoff
      4) Boiler water supply setpoint low/high limits
   h. Monitor/Trend:
      1) Boiler water return temperature
      2) Boiler water supply temperature
      3) Boiler status
      4) Outdoor air temperature
3. Boiler Circulation Pumps:
   a. Pumps shall be controlled by the boiler control package.
   b. Pumps are to be energized when the associated boiler is energized by the boiler control package
   c. Automatic/Manual Control
      1) The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the “H” position, the system shall be energized and

the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall run continuously and operate in response to BMS control and system safety circuits

d. Alarms:
   1) Boiler Pump Failure
      (a) If the status of a pump, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The pump shall be identified by its designation and shall be tagged as a "PUMP FAILURE".

e. Monitor/Trend:
   1) Boiler Pump Status
   2) Boiler Pump Speed
   3) Boiler Pump Runtime

4. Building Circulation Pumps:
   a. Pumps are VFD controlled, variable volume pumps.
   b. Pumps shall operate upon a call for heating and shall modulate to maintain a differential pressure between the heating hot water supply and return (adj.)
   c. Pumps shall operate in a duty/standby configuration. The operator shall be able to select either pump to lead via a software switch. Upon a start command a timer shall be initiate, if pump status is not detected within 15 seconds the standby pump shall start, the current duty pump shall be commanded off and an alarm shall sent to the operator's workstation. Pumps shall alternate and operate as the duty pump every 168 hours (adj.) total runtime.
   d. Automatic/Manual Control
      1) The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the "H" position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall run continuously and operate in response to EMCS control and system safety circuits
   e. Safeties/Alarms:
      1) Heating Hot Water Pump Failure
         (a) If the status of a pump, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The pump shall be identified by its designation and shall be tagged as a "PUMP FAILURE".
      2) Hot water supply setpoint low/high limits
         (a) High limit water supply temperature: 160 deg F (adj)
         (b) Low limit water supply temperature: 85 deg F (adj)
      3) Building Loop Differential Pressure Low/High Limits
   f. Monitor/Trend:
      1) Building Loop Supply Temperature
      2) Building Loop Return Temperature
      3) Building Loop Temperature Differential
      4) Building Loop Differential Pressure
      5) Pump Status
      6) Pump Speed
      7) Pump Runtime

R. **<u>Air Cooled Chiller (ACC-1) and Chilled Water Pumps (P 6-9)</u>**
   1. Chilled water system consisting of (1) air cooled scroll chiller, (2) variable speed chiller loop pumps (P-8 & P-9), and (2) variable speed building loop pumps (P-6 & P-7).
   2. Air Cooled Chiller Operation:

a. Operation:
   1) Chiller is controlled by manufacturer master controller. Refer to division 23 section “Scroll Water Chillers”.
   2) BMS to provide loop temperature setpoint, system monitoring, and enable/disable signal.
   3) Upon a call for cooling, BMS to enable the chiller master controller and provide a chilled water setpoint of 57 deg F (adj.)
      (a) BMS shall not enable chillers until operation of the chilled water main circulating pumps has been verified.
b. Unoccupied Mode Chilled Water Reset:
   1) When the building is determined to be unoccupied by the BMS building time clock system, the chilled water setpoint shall be reset to 64 deg F (adj.)
c. Safeties/Alarms:
   1) Unit failure:
   2) Unit status alarm
   3) High and low water supply temperature
      (a) High water supply temperature: 67 deg F (adj)
      (b) Low water supply temperature: 54 deg F (adj)
d. Monitor/Trend:
   1) Chiller Status
   2) Chiller Runtime

3. Chiller Loop Circulating Pumps (P-8 & P-9)
   a. Pumps are VFD controlled, variable volume pumps.
   b. Pumps shall operate upon a call for cooling and shall modulate to maintain a 7 deg F (adj.) chilled water temperature differential across the chiller loop.
   c. Pumps shall operate in a duty/standby configuration. The operator shall be able to select either pump to lead via a software switch. Upon a start command a timer shall be initiate, if pump status is not detected within 15 seconds the standby pump shall start, the current duty pump shall be commanded off and an alarm shall sent to the operator’s workstation. Pumps shall alternate and operate as the duty pump every 168 hours (adj.) total runtime.
   d. Automatic/Manual Control
      1) The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the “H” position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall run continuously and operate in response to EMCS control and system safety circuits
   e. Safeties/Alarms:
      1) Chilled Water Pump Failure
         (a) If the status of a pump, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator’s workstation. The pump shall be identified by its designation and shall be tagged as a “PUMP FAILURE".
      2) High Chilled Water Temperature Differential
         (a) If the temperature differential across the chiller loop is greater than 12 deg F (adj.) the BMS shall initiate an alarm signal
      3) Low Chilled Water Temperature Differential
         (a) If the temperature differential across the chiller loop is less than 4 deg F (adj.) the BMS shall initiate an alarm signal
      4) Low Chiller Loop Temperature

(a) If the temperature within the outdoor section of the chiller loop is less than 35 deg F (adj.) the BMS shall initiate an alarm signal

f. Monitor/Trend:
1) Chiller Loop Supply Temperature
2) Chiller Loop Return Temperature
3) Chiller Loop Temperature Differential
4) Chiller Loop Differential Pressure
5) Pump Status
6) Pump Speed
7) Pump Runtime

4. Building Loop Circulating Pumps (P-6 & P-7)
a. Pumps are VFD controlled, variable volume pumps.
b. Pumps shall operate upon a call for cooling and shall modulate to maintain a differential pressure between the chilled water supply and return (adj.)
c. Pumps shall operate in a duty/standby configuration. The operator shall be able to select either pump to lead via a software switch. Upon a start command a timer shall be initiate, if pump status is not detected within 15 seconds the standby pump shall start, the current duty pump shall be commanded off and an alarm shall sent to the operator's workstation. Pumps shall alternate and operate as the duty pump every 168 hours (adj.) total runtime.
d. Automatic/Manual Control
1) The unit shall be accompanied by an H-O-A (Hand/Off/Auto) switch on the variable frequency drive. In the "H" position, the system shall be energized and the system safety devices shall protect the circuit. With the H-O-A switch in the "A" position, the unit shall run continuously and operate in response to EMCS control and system safety circuits
e. Safeties/Alarms:
1) Chilled Water Pump Failure
(a) If the status of a pump, which has been called by the BMS to start, has not been verified as running within a period of 10 seconds (adj.), the BMS shall initiate an alarm signal at the operator's workstation. The pump shall be identified by its designation and shall be tagged as a "PUMP FAILURE".
2) Building Loop Differential Pressure Low/High Limits
f. Monitor/Trend:
1) Building Loop Supply Temperature
2) Building Loop Return Temperature
3) Building Loop Temperature Differential
4) Building Loop Differential Pressure
5) Pump Status
6) Pump Speed
7) Pump Runtime

END OF SECTION 230993

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SECTION 232113
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

A. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
B. Section 230523 - General-Duty Valves for HVAC Piping-CPL.
C. Section 230553 - Identification for HVAC Piping and Equipment-CPL.
D. Section 230719 - HVAC Piping Insulation-CPL.
E. Section 232500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
E. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings; 2021.
F. ASME B31.9 - Building Services Piping; 2025.
G. 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; 2025, with Errata.
H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
I. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2026.
J. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts; 2014 (Reapproved 2020).
K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
L. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
M. ASTM B32 - Standard Specification for Solder Metal; 2020.
N. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2018, with Editorial Revision (2024).
O. ASTM D2657 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.

P. ASTM D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics.

Q. ASTM D6394 Specification for Sulfone Plastics (SP).

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

S. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.

T. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

U. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2026.

V. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems; 2025.

W. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing; 2024.

X. ASTM F2389 - Standard Specification for Pressure-Rated Polypropylene (PP) Piping Systems; 2024a.

Y. ASTM F3226/F3226M - Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems; 2019 (Reapproved 2024).

Z. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe; 2000.

AA. AWWA C606 - Grooved and Shouldered Joints; 2022.

BB. IAPMO (UMC) - 2024 Uniform Mechanical Code; 2024.

CC. IAPMO/ANSI/CAN Z1117 - Standard for Press Connections; 2022.

DD. ICC (IMC) - International Mechanical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

EE. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

FF. NSF/ANSI Standard 359 Valves for Crosslinked Polyethylene (PEX) Water Distribution Tubing Systems.

GG. UL/ANSI 263 Standard for Safety for Fire Tests of Building Construction and Materials.

HH. UL/ANSI 2846 Standard for Fire Test of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.

1.04 SUBMITTALS

A. See Section 013300 - Submittal Procedures.

B. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.
   2. Provide manufacturers catalog information.

C. Informative submittals:
   1. Coordination Drawings: A single set of plans or BIM model, drawn to scale, indicating piping layout, size dimension by installation segment, support fixtures and schedules with all details required for installation of the system.

D. Samples: Submit selection and verification samples of piping.

E. Quality assurance/control submittals.
   1. Test reports: Upon request, submit test reports from recognized testing laboratories.
   2. Submit the following documentation.
      a. Manufacturer’s certificate stating that products comply with specified requirements.
      b. Manufacturer’s flow schedule for the distribution system.

c. Documentation that the installer is trained to install the manufacturer's products.

F. Closeout submittals: Submit the following documents.
1. Warranty documents specified herein.
2. Operation and maintenance data.
3. Manufacturer's field reports specified herein.
4. Final as-built piping layout drawing.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience, and has been trained by the manufacturer or an manufacturer-approved trainer.

B. Regulatory requirements and approvals: Ensure the piping distribution system complies with all applicable codes and regulations.
1. Certifications: Provide letters of certification indicating: Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed tradesperson.
2. Pre-installation meetings:
a. Verify project requirements, excavation conditions, system performance requirements, manufacturer's installation instructions and warranty requirements.
b. Review project construction timeline to ensure compliance or discuss modifications as required.
c. Interface with other trade representatives to verify areas of responsibility.
d. Establish the frequency and construction phase the project engineer intends for site visits and inspections by the piping manufacturer's representative.

C. Installer qualifications for PEX: Installer shall have successfully completed the Manufacturer's Systems Training Course and is able to provide proof/verification of the training. Course shall be conducted by the manufacturer or a manufacturer's representative.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
1. Store PEX piping in cartons or under cover to avoid dirt or foreign material from entering the piping.
2. Do not expose white or blue PEX piping to direct sunlight for more than one month. Do not expose red PEX piping to direct sunlight for more than six months.
3. Store piping on a flat surface to prevent unwanted deformation.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

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

1.07 WARRANTY

A. PEX-a manufacturer's warranty:
1. PEX-a manufacturer system warranty shall cover piping and fittings from defect for a duration of 25 years from the date of installation. Piping system warranty shall apply to systems constructed of pipe and fitting products sourced from the same manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. PEX-a piping: GF Building Flow Solutions (Uponor).

2.02 PEX-A PIPE AND FITTINGS

A. PEX-a (Engel-method crosslinked polyethylene) piping: SDR 9, ASTM F876 and F877 (CAN/CSA-B137.5) with an oxygen barrier meeting DIN 4726.

B. Pre-insulated PEX-a piping (1/2 inch through 2 inch nominal pipe size): PEX-a piping, with a closed-cell polyethylene foam insulation.

C. Fittings for PEX-a piping: Elbows, adapters, couplings, plugs, tees and multiport tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fittings in brass or engineered polymer (EP) manufactured by the pipe manufacturer, utilizing cold-expansion PEX-a reinforcing rings made of same material as the pipe. Fittings shall be third-party certified to NSF 14 and ASTM F1960 and shall comply with ASTM F876 and ASTM F877.

2.03 PEX-A TRANSITION FITTINGS

A. PEX-to-metal transition fittings:
   1. Manufacturers: Provide transition fittings from the same manufacturer as the piping.
   2. PEX-a to threaded transition: One-piece brass fitting with one male or female threaded end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
   3. PEX-a to copper sweat transition: One-piece brass fitting with one sweat adapter end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
   4. PEX-a to copper press transition: One-piece lead-free (LF) brass fitting with one ASME B16.51 copper press end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
   5. PEX-a to flange transition: Two-piece fitting with one steel flange conforming to ASME B16.5 and one lead-free (LF) brass adapter conforming to ASTM F1960.
   6. PEX-a to groove transition: One-piece lead-free (LF) brass fitting with one CSA B242-05 groove end in either iron pipe size (IPS) or copper tube size (CTS) and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

2.04 VALVES FOR PEX-A PIPE

A. PEX-to-PEX, brass ball valves (1/2 inch through 2 inch nominal pipe size)
   1. Manufacturers: Provide ball valve(s) from the same manufacturer as the piping system.
   2. Full-port ball valve: Two-piece, ASTM F1960 cold-expansion ends, with PEX-a reinforcing cold-expansion ring.
   3. In compliance with: 250 CWP, NSF/ANSI 359, ASTM F1960, ASTM F877 (CAN/CSA B137.5).

2.05 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 throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

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

2.06 HEATING WATER PIPING, ABOVE GRADE

A. PEX-a: NPS 2-1/2" to 3", PEX-a piping with engineered polymer (EP) or brass F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer’s recommendations.
1. PEX-a connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for ASTM F1960 connections.

B. PEX-a: NPS 2" and smaller, Pre-insulated PEX-a piping with PEX-foam insulation with engineered polymer (EP) or brass ASTM F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer’s recommendations.
1. PEX-a connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for ASTM F1960 connections.

C. Steel Pipe: NPS 2-1/2" and Greater, 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.

D. Copper Tube: NPS 2" and Smaller, 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. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.07 CHILLED WATER PIPING, ABOVE GRADE

A. PEX-a: NPS 3" and smaller, PEX-a piping with engineered polymer (EP) or brass F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.
   1. PEX-a connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for ASTM F1960 connections.

B. PEX-a: NPS 2" and smaller, Pre-insulated PEX-a piping with PEX-foam insulation with engineered polymer (EP) or brass ASTM F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.
   1. PEX-a connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for ASTM F1960 connections.

C. 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 D10.12M/D10.12 welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
   4. Mechanical Press Sealed Fittings: ASTM F3226/F3226M, ICC (IMC), and IAPMO (UMC) approved, with EPDM seals.

D. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard 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. Mechanical Press Sealed Fittings: ASME B16.51 or IAPMO/ANSI/CAN Z1117, ICC (IMC), and IAPMO (UMC) approved, with EPDM seals.

2.08 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
   1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.09 PIPE HANGERS AND SUPPORTS

A. PEX-a hangers and supports.
   1. Horizontal PEX-a piping: Install supports suitable for PEX-a piping in compliance with local codes and the manufacturer's Piping Systems Installation Guide, current edition.
      a. Support 1-1/2 inch and smaller fittings within 12 inches (0.3 m).
      b. Support 1-1/4 – 2 inch ball valves within 18 inches.
      c. Support 2-1/2 – 3 inch butterfly valves within 7 inches.

B. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
   4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
   5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
   6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Vertical Support: Steel riser clamp.
9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
11. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
12. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
13. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

C. 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.

2.10 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe of 2 Inches and Less:
1. Ferrous Piping: 150 psi brass or 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. Copper Piping: Bronze.
3. 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. Housing Material: Ductile iron, galvanized complying with ASTM A536.
2. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
3. Manufacturers:
a. Apollo Valves: www.apollovalves.com/#sle.
b. Victaulic Company: www.victaulic.com/#sle.

D. Dielectric Connections:
1. 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. Construct of galvanized steel with threaded end connections to match connecting piping.
d. Suitable for the required operating pressures and temperatures.
2. Unions:

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. PEX-a ASTM E84 installation requirements for plenums.
   1. PEX tubing shall be listed to a maximum 25 flame spread and maximum of 50 smoke developed per the requirements of ASTM E84.
      a. Nominal pipe sizes 1/2 inch and 3/4 inch: Adjacent pipe runs shall be located at least 18 inches apart.
      b. Nominal pipe sizes 3 inch and smaller supported with Uponor PEX-a Pipe Support: Pipe of fitting sections without PEX-a Pipe Support must be covered with a rated insulation. There is no minimum length of PEX-a Pipe Support segments.
      c. Nominal pipe 3 inch and smaller shall be covered with a rated insulation.

C. Cleaning and Flushing
   1. Remove temporary coverings and protection of adjacent work areas.
   2. Repair or replace damaged installed products.
   3. Clean the installed products in accordance with manufacturer’s instructions prior to owner’s acceptance.
   4. Remove construction debris from project site and legally dispose of debris.
   5. Flush the system with fresh potable water to remove any potential debris from installation.
   6. If disinfection is required, follow the manufacturer’s guidelines for the specific application.

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.
9. Prime coat exposed steel hangers and supports. See Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

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 PEX-a piping.
1. 1 Inch and smaller: Maximum Horizontal span, 2.5 feet.
   a. Per ICC PMG-1006, the above maximum hanger spacing requirements may be extended with the use of a continuous support channel such as Manufactuer's PEX-a Pipe Support
2. 1 Inch and smaller: Maximum Vertical span, 10 feet.
   a. For sizes 2 inch and smaller, a guide shall be installed midway between required vertical supports. Such guide shall prevent pipe movement in a direction perpendicular to the axis of the pipe.
3. 1-1/4 Inch and larger: Maximum Horizontal span, 4 feet
   a. Per ICC PMG-1006, the above maximum hanger spacing requirements may be extended with the use of a continuous support channel such as Uponor PEX-a Pipe Support
4. 1-1/4 Inch and larger: Maximum Vertical span, 10 feet
   a. For sizes 2 inch and smaller, a guide shall be installed midway between required vertical supports. Such guide shall prevent pipe movement in a direction perpendicular to the axis of the pipe.

B. The following is a schedule of maximum spacing for hangers and supports for all PEX-a piping using manufacturer's PEX-a pipe support, unless otherwise indicated or required.
1. Chilled water piping 3 Inch and smaller: Maximum Horizontal span, 8 feet
   a. Clamps and fixed points not required.
2. Hot water piping 3 Inch and smaller: Maximum Horizontal span, 8 feet
   a. Clamps requires every 32 feet maximum.
   b. Fixed points are required as noted (Pipes 1 inch and smaller do not required fixed points):

Length of Straight Piping Run	Number of Fixed Points	Fixed Point Spacing
0 - 63 ft. (0 - 19.2 m)	0	N/A
64 - 128 ft. (19.5 - 39 m)	1	Closest support with clamps to center
129 - 192 ft. (39 - 58.5 m)	2	Min. 64 ft. (19.5 m) apart
193 - 256 ft. (58.8 - 78 m)	3	
257 - 320 ft. (78.3 - 97.5 m)	4	

C. 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.

D. Hanger Spacing for Steel Piping.
1. 1/2 Inch, 3/4 Inch, and 1 Inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8 Inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.

3.04 FIELD QUALITY CONTROL

A. Pressure testing PEX pipe and fittings: Pressure test PEX-a piping systems in accordance with local code and manufacturer’s requirements.

B. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

C. Perform the following tests on hydronic piping:
1. Procedures in subparagraphs below are paraphrased from ASME B31.9.
2. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
3. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
4. Isolate expansion tanks and determine that hydronic system is full of water.
5. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

6. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
7. Prepare written report of testing.

D. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

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SECTION 232114
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Expansion tanks.
B. Air vents.
C. Air separators.
D. Strainers.
E. Magnetic filters.
F. Suction diffusers.
G. Pump connectors.
H. Combination pump discharge valves.
I. Pressure-temperature test plugs.
J. Balancing valves.
K. Automatic flow control valves.
L. Relief valves.
M. Pressure reducing valves.
N. Glycol system.

1.02 RELATED REQUIREMENTS

A. Section 221119 - Domestic Water Piping Specialties: Backflow preventers.
B. Section 232113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

A. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
B. 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 013300 - 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. Manufacturer's qualification statement.

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

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal, and steel support stand.

C. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced-pressure-principle backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
   1. See Section 221119 for backflow preventer specifications.

2.02 AIR VENTS

A. Manual Air Vent: 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 Air Vent:
   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. Hygroscopic Air Vent:
   1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring-loaded ball check valve.

D. Maximum Fluid Pressure: 150 psi.

E. Maximum Fluid Temperature: 250 degrees F.

2.03 AIR SEPARATORS

A. Centrifugal Air Separators/Strainers:
   1. Manufacturers:
      a. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
      b. ITT Bell & Gossett; _____: www.bellgossett.com/#sle.
      c. Taco, Inc; _____: www.taco-hvac.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. Primed steel body, tested and stamped in accordance with ASME BPVC-VIII-1 with integral bronze strainer, tangential flanged inlet and outlet connections, and internal stainless steel air collector tube.
   3. Maximum Service Flow and Pressure: 16 gpm at 125 psi.

B. Coalescing Air/Dirt Separators:
   1. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1 for maximum fluid service subject to application requirements and manufacturer's standard maximum operating conditions.
   2. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
   3. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to top of separator.

4. End Connections: Class 150 flanged for 2-1/2 inch and larger otherwise threaded.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.
7. Maximum Fluid Service Pressure: 150 psi.
8. Maximum Fluid Service Temperature: 250 degrees F.

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

B. Size 2 inch and Under:
1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer 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 MAGNETIC FILTERS

A. Description: ASME BPVC-VIII-1 compliant, packaged oxide filtration assembly configured to remove dissolved ferrous metals from hydronic systems.

B. In-line Filter Assembly:
1. Magnetic belt surrounded by stainless steel vessel and nonferrous casing.
2. Provide filter assembly with automatic air vent and EPDM flange gaskets.
3. Flange Connections: 2 inches, ASME B16.5 Class 150.

2.06 SUCTION DIFFUSERS

A. Manufacturers:
1. Grinnell Products: www.grinnell.com/#sle.
2. ITT Bell & Gossett: www.bellgossett.com/#sle.
3. Victaulic Company of America: www.victaulic.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

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.

2.07 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 Operating Service: 150 psi 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 necessary accessories including, but not limited to, swivel joints.

2.08 COMBINATION PUMP DISCHARGE VALVES

A. Triple-Duty Globe Type: Grooved cast-iron angle pattern body with bolt-on bonnet, position indicator, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, metering connectors, flow shutoff mechanism, and adjustable flow handle.

2.09 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.

2.10 BALANCING VALVES

A. Manufacturers:
   1. Armstrong International, Inc: www.armstronginternational.com/#sle.
   2. ITT Bell & Gossett: www.bellgossett.com/#sle.
   3. Taco, Inc: www.taco-hvac.com/#sle.

B. Size 2 inch and Smaller:
   1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
   2. Metal construction materials consist of bronze or brass.
   3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.

C. Size 2-1/2 inch and Larger:
   1. Provide butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
   2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
   3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.11 AUTOMATIC FLOW CONTROL VALVES

A. Manufacturers:
   1. Armstrong International; _____: www.armstronginternational.com/#sle.
   2. Taco Inc; _____: www.taco-hvac.com/#sle.
   3. Griswold.

B. Construction:
   1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
   2. Built-in lug-type outlet butterfly valve with 2-position handle.

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.

D. 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.

2.12 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.

2.13 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:

E. Provide integral check valve and strainer.

F. Maximum Inlet Pressure: 400 psi.

G. Maximum Fluid Temperature: 180 degrees F.

H. Adjustable Pressure Range: From 10 to 45 psi, set to 25 psi.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties and equipment 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. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.

J. Support pump fittings with floor-mounted pipe and flange supports.

K. Provide combination flow controls on all hydronic systems.

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.

END OF SECTION 232114

SECTION 232123
HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Circulators.

B. In-line pumps.

C. End-suction pumps.

1.02 RELATED REQUIREMENTS

A. Section 230513 - Common Motor Requirements for HVAC Equipment-CPL.

B. Section 230716 - HVAC Equipment Insulation-CPL.

C. Section 230719 - HVAC Piping Insulation-CPL.

D. Section 230923 - Direct-Digital Control System for HVAC.

E. Section 230934 - Variable-Frequency Motor Controllers-CPL.

F. Section 232113 - Hydronic Piping.

G. Section 232114 - Hydronic Specialties.

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

1.04 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES 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. Millwright's Certificate: Certify that base mounted pumps have been aligned.

D. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

E. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

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. Grundfos Pumps Corporation; _____: www.grundfos.com/#sle.

D. TACO

E. Substitutions: See Section 016000 - Product Requirements.

2.02 GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Base Mounted Pumps: Aligned by qualified millwright.

C. Electrical Requirements:
   1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
   2. Variable Frequency Drives (VFDs): Provide in accordance with Section 230934, except for integral-VFDs.
   3. Enclosures: Provide unspecified product(s) required to fit motor:

2.03 CIRCULATORS

A. Horizontal shaft, single-stage pump with direct connected, resilient-mount, oil lubricated motor for discharge pressures of up to 125 psi.

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 duty temperature.

G. Drive: Flexible coupling.

H. Electrical:
   1. Motor: 1,750 rpm unless indicated otherwise; see Section 230513.
   2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.04 IN-LINE PUMPS

A. Closed-Coupled, Single-Stage Pump: Vertical pump with radially- or horizontally-split casing; rated for discharge pressures up to 175 psi.

B. Casing: Cast iron with seal flush connection, threaded suction, and discharge ports with gauge port and drain plug.

C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.

D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.

E. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 250 degrees F maximum continuous duty temperature.

F. Electrical:
   1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 230513.
   2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
   3. Integral Controls:
      a. Variable Frequency Drive (VFD): Factory-fitted and tested with dedicated terminal box for power, instrumentation and related control wiring.

2.05 END-SUCTION PUMPS

A. Split-Coupled Pump: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi.

B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.

C. Impeller: Stainless steel, balanced, 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, 225 degrees F maximum continuous duty temperature.

G. Drive: Flexible coupling with coupling guard.

H. Baseplate: Cast iron or fabricated steel with integral drain rim.

I. Electrical:
   1. Motor: 1,750 rpm, total-enclosed, fan-cooled (TEFC); see Section 230513.
   2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

E. Provide drains for bases and seals, piped to and discharging into floor drains.

F. Check, align, and certify alignment of base-mounted pumps prior to start-up.

G. Lubricate pumps before start-up.

H. Provide side-stream filtration system for closed loop systems. Install across pump with flow from pump discharge to pump suction from pump tappings.

I. Controls: Interface each pump starter or VFD with HVAC controller; see Section 230923.

J. Controls Human-Machine Interface (HMI): HVAC operator terminal; see Section 253500.

END OF SECTION 232123

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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. Filter-driers.
H. Exterior penetration accessories.

1.02 RELATED REQUIREMENTS

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

1.03 REFERENCE STANDARDS

A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).
B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
C. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2024.
D. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.
E. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
F. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
G. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.
H. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2026.
I. ICC (IMC)-2018 - International Mechanical Code; 2018.
J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.
K. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.04 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the 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.

1.05 SUBMITTALS

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

B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

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

D. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

E. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

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 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. Mechanical Press Sealed Fittings: Double pressed type complying with UL 207 and ICC (IMC)-2018.

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. Mechanical Press Sealed Fittings: Double pressed type complying with UL 207 and ICC (IMC)-2018.

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. Vertical Support: Steel riser clamp.
   6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   8. 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.

2.02 REFRIGERANT

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

2.03 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.

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. 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.

G. 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.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Flood piping system with nitrogen when brazing.

J. Insulate piping and equipment.

K. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

L. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

M. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

N. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

O. 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.

END OF SECTION 232300

SECTION 232513
WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes water treatment for closed-loop hydronic systems.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to hydronic systems.

1.03 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from manufacturer.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

E. Water Analysis: Illustrate water quality available at Project site.

1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 PRODUCTS

2.01 HVAC WATER-TREATMENT 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. Anderson Chemical Company.
   2. Aqua-Chem, Inc.
   3. Barclay Water Management, Inc.
   4. Boland Trane Services.
   5. Cascade Water Services, Inc.

2.02 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

2.03 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter, Piston Type, Threaded:
   1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
   2. Body: Bronze.
   3. Minimum Working-Pressure Rating: 150 psig.
   4. Maximum Pressure Loss at Design Flow: 3 psig.
   5. Registration: Gallons or cubic feet.
   6. End Connections: Threaded.
   7. Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.

B. Chemical Solution Tanks:
   1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
   2. Molded cover with recess for mounting pump.
   3. Capacity: 30 gal.

C. Chemical Solution Injection Pumps:
   1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
   2. Adjustable flow rate.
   3. Metal and thermoplastic construction.
   4. Built-in relief valve.
   5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
   6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.

E. Injection Assembly:
   1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
   2. Ball Valve: Three-piece, stainless steel; selected to fit quill.
   3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
   4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.04 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

PART 3 EXECUTION

3.01 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.02 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install interconnecting control wiring for chemical-treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Bypass Feeders: Install in closed hydronic systems, including glycol heating, and equip with the following:
   a. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
   b. Install water meter in makeup-water supply.
   c. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
   d. Install a swing check on the inlet after the isolation valve.

F. Install automatic fluid make-up equipment for glycol water system, and include the following:
   a. Chemical solution tanks.
   b. Chemical solution injection pumps.
   c. Water meter in makeup supply to system.
   d. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

3.03 PIPING CONNECTIONS

A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General Duty Valves for HVAC Piping."

3.04 ELECTRICAL CONNECTIONS

A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

F. Equipment will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.

I. Comply with ASTM D3370 and with the following standards:
1. Silica: ASTM D859.
2. Acidity and Alkalinity: ASTM D1067.
3. Iron: ASTM D1068.
4. Water Hardness: ASTM D1126.

3.06 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232513

SECTION 233100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal ducts.

B. Flexible ducts.

C. Air plenums and casings.

D. Ducts for kitchen exhaust applications.

E. Ducts for laboratory and industrial-grade applications.

1.02 RELATED REQUIREMENTS

A. Section 099123 - Interior Painting: Weld priming, paint or coating.

B. Section 230713 - Duct Insulation-CPL: External insulation and duct liner.

C. Section 233300 - Air Duct Accessories.

D. Section 233319 - Duct Silencers.

E. Section 233600 - Air Terminal Units.

F. Section 233700 - Air Outlets and Inlets: Fabric air distribution devices.

1.03 REFERENCE STANDARDS

A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

E. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.

F. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems; 2025.

G. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).

H. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry; 2018, with Editorial Revision (2020).

I. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).

J. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.

K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

L. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

M. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

N. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines; 2001.

O. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012.

P. SMACNA (ROUND) - Round Industrial Duct Construction Standards; 2013.

Q. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

R. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

S. UL 1978 - Grease Ducts; Current Edition, Including All Revisions.

T. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

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

B. Product Data: Provide data for duct materials and duct connections.

C. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
11. Hangers and supports, including methods for duct and building attachment and vibration isolation.

D. Informational Submittals
1. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

E. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).

F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.

B. Provide metal duct unless otherwise indicated. Fibrous glass duct can be substituted at the Contractor's option.

C. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 233319.

D. Duct Sealing:
   1. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Duct Fabrication Requirements:
   1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
   2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
   3. Construct tees, 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 airfoil turning vanes of perforated metal with glass fiber insulation.
   4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
   5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
   6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.

2.02 METAL DUCTS

A. Material Requirements:
   1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
   2. Galvanneal Steel: hot-dip zinc-iron coated sheet steel, annealed, meets ASTM A653-09 specifications/requirements.

B. Single-Wall Rectangular Ducts And Fittings
   1. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
      a. Construct ducts of galvanized sheet steel unless otherwise indicated.
   2. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
      a. For ducts with longest side less than 36 inches (914 mm), select joint types in accordance with Figure 2-1.
      b. For ducts with longest side 36 inches (914 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
   3. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible.

C. Single-Wall Round Ducts And Fittings
   1. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
      a. Construct ducts of galvanized sheet steel unless otherwise indicated.

2. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
3. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Connectors, Fittings, Sealants, and Miscellaneous:
1. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
a. 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.
b. VOC Content: Not more than 250 g/L, excluding water.
c. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
d. For Use with Flexible Ducts: UL labeled.
2. Gasket Tape:
a. Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.
3. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
4. Hanger Fasteners: Attach hangers to structure using appropriate fasteners as follows:
a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
f. Other Types: As required.

2.03 FLEXIBLE DUCTS

A. Flexible Ducts: UL 181, Class 1, polyethylene film, mechanically fastened and rolled using galvanized steel to form spiral helix.
1. Insulation: R6 insulation with polyethylene vapor barrier film.
2. Pressure Rating: 10 in-wc positive and 5 in-wc negative.
3. Maximum Velocity: 5500 fpm.
4. Temperature Range: Minus 20 degrees F to 250 degrees F.

2.04 AIR PLENUMS AND CASINGS

A. Fabricate in accordance with SMACNA (DCS) for indicated operating pressures indicated.

B. Minimum Fabrication Requirements:
1. Fabricate acoustic plenum or casing with reinforcing turned inward.
2. Provide 16-gauge, 0.059-inch sheet steel back facing and 22-gauge, 0.029-inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers.

3. Construct panels 3 inches thick, packed with 4.5 pcf minimum glass fiber insulation media, on inverted channel of 16-gauge, 0.059-inch sheet steel.
4. Mount floor-mounted plenum or 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, 0.052-inch expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.

C. Access Doors:
1. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
2. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.
3. Provide clear wire glass observation ports, minimum 6 by 6 inch size.

2.05 DUCTS FOR KITCHEN EXHAUST APPLICATIONS

A. Provide ductwork, fittings, and appurtenances in accordance with NFPA 96, SMACNA (KVS), UL 1978, and UL 2221 requirements and guidelines.

B. Class 1 duct for air with gas and grease particle exhaust at an air velocity of 1,500 to 2,500 fpm.

C. Where ducts are not self-draining back to equipment, provide low-point drain pocket with the copper drain pipe to a sanitary sewer.

D. Design, fabricate, and install liquidtight preventing exhaust leakage into building.

E. Kitchen Hood and Grease Exhaust Duct:
1. Fabricate in accordance with ductwork manufacturer's instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.
2. Round, Single-Wall, Premanufactured Grease Exhaust Duct:
   a. UL Listed and labeled to UL 1978.
   b. Construct of 20-gauge, 0.035-inch Type 304 stainless steel.
   c. Seal joints during installation with factory-supplied overlapping V-bands and sealant.
   d. Minimum horizontal slope of 1/16 inch per foot per manufacturers listing to UL 1978.
3. Rectangular, Single-Wall, Premanufactured Grease Exhaust Duct:
   a. UL Listed and labeled to UL 1978.
   b. Construct of 16-gauge, 0.059-inch sheet steel using continuous external welded joints in rectangular sections.
4. Zero Clearance, 2-Hour Fire-Rated, Rectangular, Double-Wall, Premanufactured Grease Duct:
   a. Listed when tested in accordance with UL 1978 and ASTM E2336.
   b. Construct of 16-gauge, 0.059-inch sheet steel using continuous external welded joints in rectangular sections.
   c. Liquidtight with continuous external weld for seams and joints.
   d. Where ducts are not self-draining back to equipment, provide low-point drain pocket with copper drain pipe to sanitary sewer.
   e. Through-penetration firestop listed to UL 1479 or ASTM E814.
5. Grease Exhaust Duct Access Doors:
   a. Listed when tested in accordance with UL 1978.
   b. Provide with preinsulated door to comply with ASTM E2336.
   c. Install hinged access doors where indicated or required for access for cleaning and inspection of duct.
   d. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.

2.06 DUCTS FOR LABORATORY FUME HOODS

A. Sectional Shape and Material Requirements:
   1. Round Metal Duct:
      a. Pressure Class: Plus or minus 2 in-wc.
      b. Construction: 304 stainless sheet steel.
      c. Minimum Duct Thickness: Duct Class 1, 2 and 5; 18 gauge, 0.048 inch.
      d. Compliance: Provide ductwork, fittings, supports, hangers, and appurtenances:
         1) Round: SMACNA (ROUND) construction standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install products following the manufacturer's instructions.

C. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.

D. Flexible Ducts: Connect to metal ducts with adhesive.

E. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.

F. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and 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 a crimp in the direction of airflow.

I. Use double nuts and lock washers on threaded rod supports.

J. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

K. Connect diffusers or light troffer boots to low-pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

3.02 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.03 CLEANING

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

3.04 SCHEDULE

A.
   1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B.
   1. Ducts Connected to Fan Coil Units and Terminal Units:
      a. Pressure Class: Positive 1- (250)inch wg (Pa).
      b. Minimum SMACNA Seal Class: C.
      c. SMACNA Leakage Class for Rectangular: 16.
      d. SMACNA Leakage Class for Round:8.

2. Ducts Connected to Constant and Variable Volume Air-Handling Units:
    a. Pressure Class: Positive 3- (750)inch wg (Pa).
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 8.
    d. SMACNA Leakage Class for Round:4.

C. Return Ducts:
1. Ducts Connected to Fan Coil Units and Terminal Units:
    a. Pressure Class: Positive or negative 1- (250)inch wg (Pa).
    b. Minimum SMACNA Seal Class: C.
    c. SMACNA Leakage Class for Rectangular: 16.
    d. SMACNA Leakage Class for Round:8.
2. Ducts Connected to Constant and Variable Volume Air-Handling Units:
    a. Pressure Class: Positive or negative 2- (500)inch wg (Pa).
    b. Minimum SMACNA Seal Class: C.
    c. SMACNA Leakage Class for Rectangular: 16.
    d. SMACNA Leakage Class for Round:8.

D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    a. Pressure Class: Negative 2- (500)inch wg (Pa).
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 8.
    d. SMACNA Leakage Class for Round:4.
2. Ducts Connected to Constant and Variable Volume Air-Handling Units:
    a. Pressure Class: Negative 2- (500)inch wg (Pa).
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 8.
    d. SMACNA Leakage Class for Round:4.
3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96
    a. Pressure Class: Negative 2- (500)inch wg (Pa).
    b. Airtight/watertight.
4. Ducts Connected to Fans Exhausting Fume Hood, Laboratory, and Process (ASHRAE 62.1, Class 3 and Class 4) Air:
    a. Pressure Class: Negative 2- (500)inch wg (Pa).
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Round:2.

E. Outdoor Air Ducts:
1. All Ducts:
    a. Pressure Class: Positive 1- (250)inch wg (Pa).
    b. Minimum SMACNA Seal Class: C.
    c. SMACNA Leakage Class for Rectangular: 16.
    d. SMACNA Leakage Class for Round:8.

END OF SECTION 233100

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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. Duct access doors.

E. Duct test holes.

F. Fire dampers.

G. Flexible duct connectors.

H. Smoke dampers.

I. Volume control dampers.

J. Low leakage (Class 1A) 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; 2027.

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 and combination fire and smoke dampers.

D. Project Record Drawings: Record actual locations of access doors.

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 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. Ward Industries, a brand of Hart and Cooley, Inc: www.wardind.com/#sle.
6. 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. Manufacturers:
1. Nailor Industries, Inc; _____: www.nailor.com/#sle.
2. Pottorff; _____: www.pottorff.com/#sle.
3. Ruskin Company; _____: www.ruskin.com/#sle.

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

C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
1. Greenheck
2. Nailor Industries, Inc: www.nailor.com/#sle.
3. Pottorff: www.pottorff.com/#sle.
4. Ruskin Company: www.ruskin.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

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 labeled; spring-return, electric-type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.

F. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing

pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.

G. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.04 DUCT ACCESS DOORS

A. Manufacturers:
1. Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
2. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
3. Nailor Industries, Inc; _____: www.nailor.com/#sle.
4. Ruskin Company; _____: www.ruskin.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Access doors with sheet metal screw fasteners are not acceptable.

2.05 DUCT TEST HOLES

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

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.06 FIRE DAMPERS

A. Manufacturers:
1. Greenheck
2. Nailor Industries, Inc: www.nailor.com/#sle.
3. Pottorff; _____: www.pottorff.com/#sle.
4. Ruskin Company: www.ruskin.com/#sle.
5. 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. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream.

E. Multiple Blade Dampers: 16-gauge, 0.0598-inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

F. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.07 FLEXIBLE DUCT CONNECTORS

A. Manufacturers:
1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
2. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
3. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd.
   a. Net Fabric Width: Approximately 2 inches wide.
2. Metal: 3 inches wide, 24 gauge, 0.0239 inch thick galvanized steel.

D. Maximum Installed Length: 14 inch.

2.08 SMOKE DAMPERS

A. Manufacturers:
1. Greenheck
2. Nailor Industries, Inc: www.nailor.com/#sle.
3. Pottorff; _____: www.pottorff.com/#sle.
4. Ruskin Company: www.ruskin.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

C. Dampers: UL Class 1 airfoil blade type smoke damper, normally closed automatically operated by electric actuator.

2.09 VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Greenheck
2. Nailor Industries, Inc: www.nailor.com/#sle.
3. Pottorff; _____: www.pottorff.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. Single Blade Dampers:
1. Fabricate for duct sizes up to 6 by 30 inch.
2. Blade: 24 gauge, 0.0239 inch, minimum.

D. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches. Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.
1. Blade: 18 gauge, 0.0478 inch, minimum.

E. 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.

2.10 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

A. Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.

B. Frame:
1. Material: 20-gauge galvanized steel.
2. Free-area: Single cross section.
3. Blanked-off: Split frame into two free-area sections to allow a smaller free-area to be used for a minimum airflow intake or exhaust application and secondary free-area fully blanked-off.

C. Blade:
1. Type: Multi-blade such as V or 3V for low to medium pressure.
2. Operation: Opposed type.
3. Maximum Individual Blade Height: 8 inches.
4. Material: 12-gauge galvanized steel.

5. Authority: Opposed type, 5 to 50 percent (typically 10 percent).

D. Insulation: Water-resistant sound absorbing material.

E. Temperature Service Range: Minus 25 to 185 degrees F.

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). See 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 two 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 233300

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SECTION 233319
DUCT SILENCERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air transfer silencers.

1.02 RELATED REQUIREMENTS

A. Section 233100 - HVAC Ducts and Casings: Connections to silencers.

B. Section 233300 - Air Duct Accessories: Flexible duct connections.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

D. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES for submittal procedures.

B. Product Data: Provide catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance.

C. Shop Drawings: Indicate assembly, materials, thicknesses, dimensional data, pressure losses, acoustical performance, layout, and connection details.

D. Manufacturer's Installation Instructions: Indicate installation procedures necessary to maintain integrity of sound isolation.

E. Project Record Documents: Record actual locations of cross-talk silencers.

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. Air transfer silencers shall be installed in accordance with NFPA 90A and with NFPA 90B.

C. Air transfer silencer performance must have been substantiated in a NVLAP test facility in accordance with ASTM E477.

D.

1.06 WARRANTY

A. Provide 12 month manufacturer warranty from date of shipment for duct air transfer silencers.

PART 2 PRODUCTS

2.01 AIR TRANSFER SILENCERS

A. Manufacturers:
   1. Price Industries, Inc; _____: www.priceindustries.com/#sle.
   2. Spiral Pipe of Texas, Inc; _____: www.spotusa.com/#sle.
   3. SEMCO LLC, Flakt Woods Group; _____: www.semcohvac.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Duct sections with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA (DCS) HVAC Duct Construction Standards.

C. Configuration: Rectangular, lined with inner casing with splitters with radiused noses and contoured tails, ____ high, ____ wide, .

D. Materials:
   1. Outer Casing: Minimum 22 gauge, 0.0299 inch thick galvanized steel with mastic filled lock formed seams, 3 inch long, 11 gauge, 0.1196 inch slip joint on both ends.
   2. Inner Casing and Splitters: Minimum 24 gauge, 0.0239 inch thick perforated galvanized steel.
   3. Fill: Glass fiber or mineral wool of minimum 4 lb/cu ft density.
   4. Fill Liner: Bonded glass fiber matting.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION 233319

SECTION 233423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof downblast centrifugal exhaust fans

B. Roof upblast centrifugal exhaust fans

C. Roof fume exhaust fans

1.02 RELATED REQUIREMENTS

A. Section 233100 - HVAC Ducts and Casings.

B. Section 233300 - Air Duct Accessories: Backdraft dampers.

1.03 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.

B. AMCA 99 - Standards Handbook; 2025.

C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

G. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

H. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; 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 013300 - SUBMITTAL PROCEDURES 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. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

D. Design Calculations:
   1. Roof Curbs and Exhaust Fans: Comply with wind performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Refer to section 230550 Wind Restraint for HVAC Systems

E. Informational Submittals:
   1. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

F. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

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 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
   1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid.
   2. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station.

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.

2.02 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: Comply with AMCA 204.

B. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.

C. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.

D. Fabrication: Comply with AMCA 99.

E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

F. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

2.03 ROOF DOWNBLAST CENTRIFUGAL EXHAUST FANS

A. General Description:
   1. Downblast fan shall be for roof mounted applications
   2. Performance capabilities up to 14,500 cubic feet per minute (cfm) and static pressure to 2.75 inches of water gauge
   3. Fans are available in twenty sizes with nominal wheel diameters ranging from 8 inches through 30 inches (071 - 300 unit sizes)
   4. Maximum continuous operating temperature is 180 Fahrenheit (82.2 Celsius)
   5. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

B. Wheel:

1. Constructed of aluminum
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

C. Motors:
1. Electronically Commutated Motor
   a. Motor enclosures: Open type
   b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
   c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
   d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
   e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
   f. Motor shall be a minimum of 85% efficient at all speeds.

D. Housing:
1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum
2. Shroud shall have an integral rolled bead for extra strength
3. Shroud shall be drawn from a disc and direct air downward
4. Lower windband shall have a formed edge for added strength
5. Motor cover shall be drawn from a disc
6. All housing components shall have final thicknesses equal to or greater then preformed thickness.
7. Curb cap shall have pre-punched mounting holes to ensure correct attachment
8. Rigid internal support structure
9. Leak proof

E. Housing Supports and Drive Frame:
1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

F. Vibration Isolation:
1. Rubber isolators
2. Sized to match the weight of each fan

G. Disconnect Switches:
1. NEMA rated: 1
2. Positive electrical shut-off
3. Wired from fan motor to junction box installed within motor compartment

H. Options/Accessories:
1. Birdscreen:
   a. Material Type: Galvanized
   b. Protects fan discharge
2. Roof Curbs:
   a. Type: Welded, straight sided curb
   b. Mounted onto roof with fan

c. Material: Galvanized
d. Insulation thickness: 1 inch
e. Flashing Flange: 2 inch
f. Coating Type: None

3. Curb Seal:
   a. Rubber seal between the fan and the roof curb
4. Dampers:
   a. Type: Motorized
   b. Prevents outside air from entering back into the building when fan is off
   c. Balanced for minimal resistance to flow
   d. Galvanized frames with prepunched mounting holes
5. Hinge Kit:
   a. Aluminum hinges
   b. Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning
6. Pressure Probe:
   a. ¼ inch diameter tube in the fan venturi that allows hook up to manometer

2.04 ROOF UPBLAST CENTRIFUGAL EXHAUST FANS

A. General Description:
1. Discharge air directly away from the mounting surface
2. Upblast fan shall be for roof mounted applications for fan sizes 060-300 or wall mounted applications for fan sizes 060-200
3. Performance capabilities up to 14,700 cubic feet per minute (cfm) and static pressure to 3 inches of water gauge
4. Fans are available in twenty-two sizes with nominal wheel diameters ranging from 9 inches through 30 inches (060 - 300 unit sizes)
5. Maximum continuous operating temperature for fan sizes 098-300 is 400 Fahrenheit (204.4 Celsius) and for fan sizes 060-095 is 130 Fahrenheit (54.4 Celsius)
6. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

B. Wheel:
1. Material type: aluminum, non-stick coating
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

C. Motors:
1. Electronically Commutated Motor
   a. Motor enclosures: Open type
   b. b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
   c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
   d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
   e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.

f. Motor shall be a minimum of 85% efficient at all speeds.

2. Housing:
   a. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable.
   b. Housing shall have a rigid internal support structure. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing.
   c. Windband to include an integral rolled bead for strength.
   d. Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable.
   e. Curb cap to have integral deep spun inlet venturi and pre-punched mounting
   f. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
   g. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it.
3. Motor Cover:
   a. Constructed of aluminum
4. Vibration Isolation:
   a. Double studded true isolators
   b. No metal to metal contact
   c. Sized to match the weight of each fan
5. Disconnect Switches:
   a. NEMA rated: 1
   b. Positive electrical shut-off
   c. Wired from fan motor to junction box installed within motor compartment
6. Drain Trough:
   a. Allows for one-point drainage of water, grease, and other residues
7. Options/Accessories:
   a. Birdscreen:
      1) Construction of Stainless
      2) Protects fan discharge
   b. Clean Out Port:
      1) Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
   c. Roof Curbs:
      1) Type: Welded, straight sided curb
      2) Mounted onto roof with fan
      3) Material: Galvanized
      4) Insulation thickness: 1 inch
      5) Flashing Flange: 2 inch
   d. Curb Seal
      1) Types: Foam Seal
      2) Typically mounted between the fan curb cap and the roof curb
   e. Dampers:
      1) DAMPERS ARE NOT PERMITTED WHEN FANS ARE USED FOR GREASE REMOVAL. REFER TO MECHANICAL SCHEDULES.
      2) Type: Motorized
      3) Prevents outside air from entering back into the building when fan is off
      4) Balanced for minimal resistance to flow
      5) Galvanized frames with pre-punched mounting holes
   f. Grease Trap:

1) Constructed of aluminum
2) Collects grease residue

g. Hinge Kit:
1) Aluminum hinges
2) Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning

h. Hinge Base:
1) Aluminum hinges
2) Hinges and restraint cables are mounted to a base (sleeve)
3) Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning

i. Heat Baffle:
1) 1 inch thick insulation shield that prevents heat from radiating into the motor compartment

j. Pressure Probe:
1) ¼ inch diameter in the fan venturi that allows hook-up to manometer

2.05 ROOF FUME EXHAUST FANS

A. General:
1. Base fan performance at standard conditions (density 0.075 Lb. /ft^3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
3. Each fan shall be direct drive in AMCA arrangement 4 according to drawings.
4. Normal operating temperature up to 104 Degrees Fahrenheit (40 Deg. Celsius).
5. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model and individual serial number.
6. Fans to be equipped with lifting lugs.
7. Constructed of heavy gauge steel
8. After fabrication, untreated steel components go through a multi-stage cleaning and pre-treatment process before being finished with a high-performance powder coating having a minimum thickness of 2-4 mils, electrostatically applied and baked. Finish color shall be RAL-7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method. No uncoated metal fan parts will be allowed.
9. When properly anchored to the roof structure, the standard fan / stack assembly shall withstand wind loads of up to the equivalent load of 125 mph (200 km/hr) windspeed, without the need for guy wires or additional structural support.

B. Fan Housing and Integral Stack:
1. Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan shall be of airtight construction with the scroll panel material formed and embedded into the side panels. All interior and exterior surface untreated steel shall be coated with a high-performance powder coating.
3. Fan wheel will be directly coupled to the motor shaft.
4. Housing and motor support shall be constructed of bolted framework.
5. Housing shall include discharge stack of the same material as fan housing to increase the overall discharge height of the unit. Minimum overall unit height with stack to be 7 feet (2.1m) from the roof deck.
6. Stack material to be a minimum of 18 gauge. Stack to match outlet dimensions of the fan and shall not add additional static pressure drop to the exhaust fan. Stack discharge shall have tapered design increasing exit velocity and not adding additional static pressure drop to the exhaust fan.

7. No discharge rain caps or flapper caps are permitted as to interfere with exhaust airflow.
8. Drain connection shall be located at lowest part of scroll housing to prevent moisture build-up in the interior of fan.
9. Fan shall be provided with integral inlet box and curb cap constructed of same material and coated to match fan housing, with access panel for inspection of fan wheel and duct.
10. Units with integral inlet box shall be provided with matching roof curb. Roof curb shall be constructed of 14 ga. galvanized steel, include one inch of insulation and be provided with adjustable duct support bar for connecting building duct to roof curb.
11. Units with integral inlet box shall be provided with a interlocked, motorized back draft damper to prevent airflow back into the building when exhaust fan is not in operation. Damper sized to match inlet area of inlet box and mounted in the roof curb. Back draft damper shall be constructed with aluminum frame, extruded aluminum blades and vinyl seals on closing edge.

C. Fan Wheel:
1. The fan wheel shall be of the single width backward inclined centrifugal type.
2. Fan Wheel shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
3. The wheel and fan inlet shall be carefully matched and have precise running tolerances for maximum performance and operating efficiency.

D. Fan Motors and Drive:
1. EC Motor type
a. Motors shall be open type enclosure and electronic commutation type motor (ECM) specifically designed for fan applications. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.

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. Install power ventilators level and plumb.

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

G. Ductwork connections: Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

H. Electrical connections: Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

I. Field quality control:
1. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
2. Prepare test and inspection reports.

END OF SECTION 233423

SECTION 233439
AIR DESTRATIFICATION FANS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Destratification fans for thermal equalization of buildings.

1.02 REFERENCES

A. UL 507: Underwriters Laboratory Standard for Electric Fans

B. CAN//CSA-C22.2 No. 1113: Safety of household and similar electrical appliances.

C. UL 94 5VA: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

D. ISO3744 Engineering Grade Acoustical Testing

E. NEC: National Electric Code.

F. ETL: Listed for US and Canada in Intertek Directory of Listed Products.

1.03 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES for submittal procedures.

B.
1. Power requirements and mounting recommendations.
2. Fan velocity profile showing isothermal feet per minute (FPM) delivery at various distances from fan.

C. Shop Drawings:
1. Placement Drawings: Include manufacturer’s placement recommendation diagram.
2. Wiring Diagrams.
3. Mounting details, including safety restraint where required.

D. Manufacturer’s Instructions: Provide manufacturer’s “Installation, Operation, and Maintenance Manual”

E. Schedule

1.04 PROJECT CONDITIONS

A. Maintain temperature, humidity, and ventilation within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.05 WARRANTY

A. Destratification

B. Substitutions: See Section 016000 - Product Requirements.

C. Performance: Coordinated design of housing, stator and motor shall provide columnar laminar airflow to produce a minimum of 100 fpm at center of column at grade level when installed within 2’-0” of ceiling. Refer to manufacturer’s airflow velocity profiles for jet pattern and throw data.

D. Housing: The fan housing shall be made of ABS resin, rated 5VA for flame resistance.
1. Housing color: As scheduled

E. Hardware: Stainless steel for increased corrosion resistance.

F. Safety Cable: Supplied with 6’-0” steel cable fastened to seismic restraint point integrated into the fan housing. Safety restraint attached to primary mounting handle will not be accepted.

G. Motor Mounting: Enclosed in housing, above stator.

H. Motor: Electronically commutated motor, up to 92% efficient, 230mm in diameter. Plastic blades and hub. Ball bearings shall be permanently lubricated and shielded. Up to 421 cfm, 1700 rpm, 69 dBA. Thermally protected motor with an operating range of -22° F (-30° C) to 122° F (50° C).

I. Stator: The fan shall be equipped with a curved multiple-vane stator coordinated with fan design for maximizing columnar laminar flow.

J. Certification: UL Standard 507 for Safety Electric Fans, CAN//CSA-C22.2 No. 1113 and UL 94 5VA as certified by nationally recognized testing laboratory. Acceptable laboratories include ETL, UL or other nationally recognized testing laboratories.

K. Identification: Permanently affixed manufacturer's nameplate including the following: Model Number, Serial Number, Motor Power Specifications, Country of Manufacture and Safety Marks: ETL (US & CA) & CE (EU).

PART 3 EXECUTION

2.01 EXAMINATION

A. Do not begin installation until supporting structure and interior work have been properly completed.

B. Check location and availability of utility services to ensure proper voltage and installation preparation.

C. Installation of miscellaneous support, if required, electrical wire and wiring, conduit, fuses, and disconnect switches other than those provided by fan manufacturer are specified in other sections.

D. Examine the substrate and conditions under which the Fan is to be installed. Notify the Architect in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

2.02 INSTALLATION

A. Install destratification fan according to manufacturer's written recommendations.

B. Fan to be mounted at a maximum of 2'-0" from ceiling deck to ensure thermal/humidity equalization from ceiling to floor.

C. Adjust unit as required for proper operation in accordance with manufacturer's installation instructions.

2.03 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

SECTION 233700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Square Plaque Diffusers.

B. Steel Round Plaque Diffusers.

C. Steel Round Cone Diffusers.

D. Slot Diffusers and Slot Diffuser Plenums.

E. Steel Louvered Supply Grille.

F. Steel Louvered Return Grille.

G. Steel Heavy Duty Gym Grille.

H. Goosenecks.

I. Gravity ventilators.

1.02 RELATED REQUIREMENTS

A. Section 099123 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.03 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.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

G. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

H. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.04 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES 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.

C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication.

D. Project Record Documents: Record actual locations of units and control components.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions (if applicable), and maintenance and repair data.

1.05 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.

1.06 WARRANTY

A. Provide 12 month manufacturer warranty from date of shipment of diffusers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Price Industries: www.price-hvac.com/#sle.

B. Krueger-HVAC: www.krueger-hvac.com/#sle.

C. Greenheck

D. Substitutions: See Section 016000 - Product Requirements.

2.02 SQUARE PLAQUE DIFFUSERS

A. General: The square plaque diffuser shall be supplied to deliver a 360 degree radial, horizontal air flow pattern. The back cone shall be a one-piece die-formed design with smooth, aerodynamically designed surfaces and no corner joints. This contoured design shall protect the ceiling and help to prevent smudging and streaking.

B. Description: Furnish and install square plaque ceiling diffusers of sizes and mounting types designated by the plans and air distribution schedule.

C. Construction:
   1. Diffusers shall be constructed of scheduled material, and shall consist of a seamless, one-piece, precision formed back pan that incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct.
   2. An inner plaque assembly shall be incorporated and shall drop no more than ¼ inch below the ceiling plane to assure proper air distribution performance.
   3. The inner plaque assembly shall be completely removable from the room side to allow for full access to any dampers or other ductwork components located near the diffuser neck.
   4. The diffuser shall integrate with all duct sizes shown on the plans without affecting the face size and appearance of the unit.
   5. The face panel shall have smooth edges and rounded corners to blend with the back cone.
   6. The diffuser ceiling module size shall be as scheduled:

D. Paint Specification:
   1. Paint finish shall be as scheduled:
      a. Baked-on powder coat finish.
         1) The paint film thickness shall be a minimum of 2 mils.
         2) The finish shall have a hardness of 2H as tested in accordance with ASTM D3363.
         3) The finish shall pass an ASTM B117 Corrosive Environment Salt Spray Test for 1000 hours with no measurable creep, rusting or blistering as per ASTM D1654, D610 and D714.
         4) The finish shall pass an ASTM D870 Water Immersion test of a minimum of 500 hours with no measurable with no rusting or blistering as per ASTM D610 and D714.
         5) The finish shall have an impact resistance of 100 inch-pounds in accordance with ASTM D2794.

E. Mounting Frame:
   1. The diffuser mounting frame shall be suitable for lay-in or surface mount applications with the following frame style:
      a. 15/16 inch wide flat T-bar

2.03 STEEL ROUND PLAQUE DIFFUSERS

A. General: The round plaque diffuser shall be supplied to deliver a 360 degree radial, horizontal air flow pattern. The back cone shall be a one-piece die-formed design with smooth, aerodynamically designed surfaces. This contoured design shall protect the ceiling and help to prevent smudging and streaking.

B. Description: Furnish and install round plaque ceiling diffusers of sizes and mounting types designated by the plans and air distribution schedule.

C. Construction:
   1. Diffusers shall be heavy gauge steel construction, and shall consist of a seamless, one-piece, precision formed outer cone that incorporates a round inlet collar.
   2. The inner plaque assembly shall be completely removable from the room side without tools to allow for full access to any dampers or other ductwork components located near the diffuser neck.
   3. The diffuser shall integrate with all duct sizes shown on the plans without affecting the face size and appearance of the unit.
   4. The airflow discharge pattern shall be field adjustable from horizontal to vertical by repositioning the mounting screws to one of three positions.
      a. Vertical airflow pattern.
      b. Horizontal airflow pattern for surface mount applications.
      c. Horizontal airflow pattern for exposed duct applications.
   5. Paint Specification:
      a. Paint finish shall be as scheduled:
         1) Baked-on powder coat finish.
            (a) The paint film thickness shall be a minimum of 2 mils.
            (b) The finish shall have a hardness of 2H as tested in accordance with ASTM D3363.
            (c) The finish shall pass an ASTM B117 Corrosive Environment Salt Spray Test for 1000 hours with no measurable creep, rusting or blistering as per ASTM D1654, D610 and D714.
            (d) The finish shall pass an ASTM D870 Water Immersion test of a minimum of 500 hours with no measurable with no rusting or blistering as per ASTM D610 and D714.
            (e) The finish shall have an impact resistance of 100 inch-pounds in accordance with ASTM D2794.
   6. Mounting Frame: The diffuser mounting frame shall be suitable for surface mount or exposed duct mount applications.

2.04 STEEL ROUND CONE DIFFUSER

A. General: The round cone diffuser shall be supplied to deliver a 360 degree radial, horizontal airflow pattern. The cones shall be one-piece spun construction with smooth, aerodynamically designed surfaces. This contoured design shall protect the ceiling and help to prevent smudging and streaking.

B. Description: Furnish and install round cone ceiling diffusers of sizes and mounting types designated by the plans and air distribution schedule.

C. Construction:
   1. Diffusers shall be heavy-gauge steel construction, and shall consist of four seamless, one-piece, spun cones that incorporate a round inlet collar of sufficient length for connecting rigid or flexible duct.
   2. The diffuser shall integrate with all duct sizes shown on the plans.
   3. An inner cone assembly shall consist of 3 cones which drop below the ceiling plane to assure optimal VAV air diffusion performance. The inner cone assembly shall be

completely removable from the diffuser face to allow for full access to any dampers or other ductwork components located near the diffuser neck.

4. Allow adjustment of the inner cones by turning the small center cone to achieve full horizontal to full vertical air pattern control.
5. The diffuser nominal duct diameter shall be available from a minimum size of six inches to a maximum of 36 inches.

D. Paint Specification:
1. Paint finish shall be as scheduled:
a. Baked-on powder coat finish.
1) The paint film thickness shall be a minimum of 2 mils.
2) The finish shall have a hardness of 2H as tested in accordance with ASTM D3363.
3) The finish shall pass an ASTM B117 Corrosive Environment Salt Spray Test for 1000 hours with no measurable creep, rusting or blistering as per ASTM D1654, D610 and D714.
4) The finish shall pass an ASTM D870 Water Immersion test of a minimum of 500 hours with no measurable with no rusting or blistering as per ASTM D610 and D714.
5) The finish shall have an impact resistance of 100 inch-pounds in accordance with ASTM D2794.

2.05 SLOT DIFFUSERS AND SLOT DIFFUSER PLENUMS

A. Description:
1. Furnish and install supply and return slot diffusers in sizes and capacities as shown by the plans and air distribution schedule.
2. Provide drawings accompanied by an itemized list indicating the unit locations and appropriate product submittal drawings provided by the manufacturer. Exact dimensions of the walls and ceiling are per the architectural drawings.

B. Construction:
1. The diffusers shall have 1 to 10 discharge slots with 1/2 inch, 3/4 inch, 1 inch, or 1-1/2 inch slot width.
2. The supply diffusers shall have aerodynamically curved “ice-tong” shaped pattern controllers for 180 degree air pattern control and airflow dampering, if required.
3. The return units shall match the supply units in appearance.
4. The diffuser border shall be extruded aluminum construction with extruded aluminum spacers and flush end caps.
5. Continuous length units shall be provided with factory assembled corner modules to suit drawings and site conditions. Splice plates and alignment plates shall be provided to align continuous slot assemblies. The maximum section length shall be 72 inches.
6. The linear slot diffusers shall be compatible for[surface mounting or T-bar lay in mounting] with the following border style:
a. Inverted T-bar, 15/16 inch lay-in flush, or lay-on frame

C. Performance: Performance of the selected slot diffusers shall be based on catalogued data obtained with the pattern controllers set in the normal operating position and a compatible supply air plenum, and tested in accordance with ASHRAE 70.

D. Paint Specification:
1. Paint finish shall be as scheduled:
a. Baked-on powder coat finish.
1) The paint film thickness shall be a minimum of 2 mils.
2) The finish shall have a hardness of 2H as tested in accordance with ASTM D3363.

3) The finish shall pass an ASTM B117 Corrosive Environment Salt Spray Test for 1000 hours with no measurable creep, rusting or blistering as per ASTM D1654, D610 and D714.
4) The finish shall pass an ASTM D870 Water Immersion test of a minimum of 500 hours with no measurable with no rusting or blistering as per ASTM D610 and D714.
5) The finish shall have an impact resistance of 100 inch-pounds in accordance with ASTM D2794.

E. Straight Shoulder Diffuser Plenum:
1. Description: Slot supply and return slot diffusers shall be furnished and installed with slope shoulder plenum in sizes and capacities as shown by the plans and air distribution schedule.
2. Construction:
a.
b. The plenum assembly shall have straight shoulders for enhanced throw characteristics.
c. The plenum assembly shall have a side inlet configuration in sizes to fit slot diffusers with one to four slots.
d. The plenum shall be available to suit both drywall and lay-in applications.
e. The plenum shall be internally lined with 1/4 inch thick fiber free insulation.

2.06 STEEL LOUVERED SUPPLY GRILLE

A. Description: Furnish and install steel louvered supply grilles and registers of sizes and mounting types designated by the plans and air distribution schedule.

B. Construction:
1. The grille blades and border shall be steel construction.
2. Grilles shall be double deflection louver type, and shall have:
a. Two sets of fully adjustable blades with 3/4 inch on center blade spacing.
3. The grilles front blade orientation shall be:
a. Front blades parallel to the long dimension.

C. Paint Specification:
1. Paint finish shall be as scheduled:
a. Baked-on powder coat finish.
1) The paint film thickness shall be a minimum of 2 mils.
2) The finish shall have a hardness of 2H as tested in accordance with ASTM D3363.
3) The finish shall pass an ASTM B117 Corrosive Environment Salt Spray Test for 1000 hours with no measurable creep, rusting or blistering as per ASTM D1654, D610 and D714.
4) The finish shall pass an ASTM D870 Water Immersion test of a minimum of 500 hours with no measurable with no rusting or blistering as per ASTM D610 and D714.
5) The finish shall have an impact resistance of 100 inch-pounds in accordance with ASTM D2794.

D. Options:
1. Border Style:
a. The grille shall be suitable for surface mounting, T-bar lay-in mounting, or spiral duct frame mount, complete with a border in the following styles:
1) 1-1/4 inch flat frame (required for spiral duct mount).
2) 1 inch narrow frame.

3) Panel mount border. The maximum grille size shall equal the module size minus four inches.

2. Mounting Frames:
   a. The grille shall be supplied with mounting frames as scheduled:
      1) 3/8 inch flat border mounting frame.
      2) Spiral duct mounting frame.

2.07 STEEL LOUVERED RETURN GRILLE

A. Description: Furnish and install steel louvered return grilles and registers of sizes and mounting types designated by the plans and air distribution schedule.

B. Construction:
   1. The grille blades and border shall be steel construction.
   2. Grilles shall be 45 degree deflection fixed louver type to minimize see-through, and shall have:
      a. One set of fixed blades with 1/2 inch on center blade spacing.
   3. The grilles blade orientation shall be:
      a. Blades parallel to the long dimension.

C. Paint Specification:
   1. Paint finish shall be as scheduled:
      a. Baked-on powder coat finish.
         1) The paint film thickness shall be a minimum of 2 mils.
         2) The finish shall have a hardness of 2H as tested in accordance with ASTM D3363.
         3) The finish shall pass an ASTM B117 Corrosive Environment Salt Spray Test for 1000 hours with no measurable creep, rusting or blistering as per ASTM D1654, D610 and D714.
         4) The finish shall pass an ASTM D870 Water Immersion test of a minimum of 500 hours with no measurable with no rusting or blistering as per ASTM D610 and D714.
         5) The finish shall have an impact resistance of 100 inch-pounds in accordance with ASTM D2794.

D. Options:
   1. Border Style:
      a. The grille shall be suitable for surface mounting, T-bar lay-in mounting, or spiral duct frame mount, complete with a border in the following styles:
         1) 1-1/4 inch flat frame (required for spiral duct mount).
         2) 1 inch narrow frame.
         3) Panel mount border. The maximum grille size shall equal the module size minus four inches.
   2. Mounting Frames
      a. 3/8 inch flat border mounting frame.

2.08 STEEL HEAVY DUTY GYM GRILLE

A. Description: Furnish and install steel heavy duty gym grilles and registers of sizes and mounting types designated by the plans and air distribution schedule.

B. Construction:
   1. The grille blades and border shall be steel construction.
   2. The 14 gauge steel border shall have smooth contours to reduce the possibility of injury to occupants when installed in a gymnasium.
   3. Grilles shall be fixed louver type, and shall have:
      a. Forty-five (45) degree deflection, 3/4 inch on center blade spacing.

4. The grille blade orientation shall be, as indicated on the outlet schedule.
    a. Front blades parallel to the long dimension.
5. The grille shall be suitable for surface mounting with 1-1/4 inch flat border.

C. Paint Specification:
1. Paint finish shall be as scheduled:
    a. Baked-on powder coat finish.
        1) The paint film thickness shall be a minimum of 2 mils.
        2) The finish shall have a hardness of 2H as tested in accordance with ASTM D3363.
        3) The finish shall pass an ASTM B117 Corrosive Environment Salt Spray Test for 1000 hours with no measurable creep, rusting or blistering as per ASTM D1654, D610 and D714.
        4) The finish shall pass an ASTM D870 Water Immersion test of a minimum of 500 hours with no measurable with no rusting or blistering as per ASTM D610 and D714.
        5) The finish shall have an impact resistance of 100 inch-pounds in accordance with ASTM D2794.

2.09 GOOSENECKS

A. Fabricate in accordance with of minimum 18 gauge, 0.0598 inch galvanized steel.

B. Mount on minimum 12 inch high curb base where size exceeds 9 by 9 inch.

2.10 GRAVITY VENTILATORS

A. Hood Relief Gravity Ventilator:
1. Manufacturers:
    a. American Coolair Corporation: www.coolair.com/#sle.
    b. Greenheck Fan Corporation: www.greenheck.com/#sle.
    c. Loren Cook Company: www.lorencook.com/#sle.
    d. Substitutions: See Section 016000 - Product Requirements.
2. General:
    a. Low silhouette for relief applications with natural gravity or negative pressure system(s).
    b. Performance ratings and factory testing in accordance with AMCA 511 and AMCA 550.
    c. Suitable for non-ducted applications.
    d. Equipment to bear permanently affixed manufacturer's nameplate listing model and serial number.
3. Hood and Base:
    a. Material: Aluminum.
    b. Hood Construction: Precision formed, arched panels with interlocking seams.
    c. Vertical End Panels: Fully locked into hood end panels.
    d. Curb Cap: Pre-punched mounting holes for installation.
4. Birdscreen:
    a. Fabricate in accordance with ASTM B221 (ASTM B221M).
    b. Construction: 1/2 inch Galvanized mesh.
    c. Horizontally mounted across hood intake area.
5. Hood Support: Galvanized steel construction and fastened so hood can be removed completely from base or hinged open.
6. Options/Accessories:
    a. Insect Screen:
        1) Fabricate in accordance with ASTM B221 (ASTM B221M).

2) Construct of fine mesh aluminum.
3) Fitted to top of throat to prevent entry of insects.
4) Coating: Thermo-setting polyester urethane.

B. Spun Aluminum Relief Gravity Ventilator:
1. Manufacturers:
a. American Coolair Corporation; _____: www.coolair.com/#sle.
b. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.
c. Loren Cook Company; _____: www.lorencook.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. General:
a. Provide low silhouette configuration for relief applications with natural gravity or negative pressure system.
b. Performance ratings and factory testing in accordance with AMCA 511 and AMCA 550.
c. Suitable for non-ducted applications.
d. Equipment to bear permanently affixed manufacturer's nameplate listing model and serial number.
3. Hood:
a. Material: Aluminum.
b. Internal structure constructed of galvanized steel.
4. Birdscreen:
a. Fabricate in accordance with ASTM B221 (ASTM B221M).
b. Construction: 1/2 inch galvanized mesh.
c. Horizontally mounted across hood intake area.
5. Housing:
a. Curb Cap:
1) Type: Hinged.
2) Construction: Aluminum.
3) Integral deep spun inlet venturi with pre-punched mounting holes to ensure correct attachment to roof.
b. Windband:
1) One piece spun aluminum construction with uniform, original material thickness throughout housing.
2) Include integral rolled bead for strength.
6. Options/Accessories:
a. Insect Screen:
1) Fabricate in accordance with ASTM B221 (ASTM B221M).
2) Fine mesh aluminum construction.
3) Fit into top of throat to prevent entry of insects.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.

C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.

D. Install diffusers to ductwork with air tight connection.

E. Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.

F. Paint ductwork visible behind air outlets and inlets matte black, see Section 099123.

3.02 PROTECTION

A. Protect installed products until completion of project.

B. Replace, repair, or touch-up damaged products before Substantial Completion.

END OF SECTION 233700

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SECTION 235100
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Boiler Combustion Air Intake

B. Special gas venting.
   1. Double Wall AL29-4C
   2. Single Wall Polypropylene Vent Systems

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 230716 - HVAC Equipment Insulation-CPL.

1.03 REFERENCE STANDARDS

A. ANSI Z223.1 - National Fuel Gas Code; 2024.

B. NFPA 54 - National Fuel Gas Code; 2024.

C. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment; 2024.

D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

E. SMACNA (PVC) - Thermoplastic Duct (PVC) Construction Manual; 1995.

F. UL 1738 - Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV; Current Edition, Including All Revisions.

1.04 DEFINITIONS

A. 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.

B. 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 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES 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.

D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.

E. Sizing Calculations.

PART 2 PRODUCTS

2.01 BOILER COMBUSTION AIR INTAKE

A. Round Thermoplastic (PVC I) Duct:
   1. Class 5 Air Duct Capacity:
      a. Pressure Class: Minus 2 in-wc.
      b. Maximum Temperature: 100 degrees F.
   2. Protection: Apply ultraviolet protection for segments exposed to direct sunlight.

3. Compliance: Provide reinforced ductwork, fittings, supports, hangers, and appurtenances in compliance with SMACNA (PVC).

2.02 SPECIAL GAS VENTING (CATEGORY IV)

A. Double Wall AL29-4C
   1. Construction:
      a. Vent shall be factory-built special gas type, double wall, engineered and designed for use on Category I, II, III, and IV appliances, or as specified by the equipment manufacturer.
      b. Maximum continuous flue gas temperature not to exceed 550°F (288°C) for gas burning appliances. Maximum temperature for appliances approved to vent with Type L-Vent (gas or oil) is 570°F (299°C).
      c. Vent shall be constructed with an inner conduit constructed of AL29-4C® or 29-4 (S44735) superferritic stainless steel with a minimum thickness of .015" for diameters 3"-8", .020" for diameters 10"-16", .025" for diameters 18"-24", and .035" for 26" and greater.
      d. Vent shall be listed for an internal static pressure of 15" w.g. and tested to 37" w.g.
      e. All inner wall conduit components shall be manufactured from AL29-4C® or 29-4 (S44735). The joint closure system shall be an Inner Wall Mechanical Locking Strap design. Joints shall not use screws or fasteners that penetrate the inner conduit.
      f. Vent shall be constructed with a factory installed gasket used to seal the joint for diameters 4"–16". Use of gasket lube, available from the factory, should be used for maximizing gasket life and ease of installation. For diameters 18"- 32", joints shall be sealed with factory supplied RTV sealant.
      g. Inner wall joints shall be designed with a male and female overlapping metal-metal connection to maintain condensate on the AL29-4C stainless steel. Proper ¼" per foot pitch must be maintained at all times and condensate should flow back toward the appliance to the required number of drains.
      h. The outer wall casing shall be constructed of 430 stainless steel that shall not require additional surface preparation, such as painting, in order to withstand the outdoors or high humidity environments.
      i. Inner conduit and outer wall casing shall be constructed with a one-inch air space between them and in such a fashion that prevents cross-alloy contamination.
      j. Tees and elbows shall provide a pressure drop less than 15 feet equivalent horizontal vent.
      k. Fittings that increase or decrease vent diameter shall be asymmetric in construction with a flat wall that maintains a straight line with adjoining parts in order to facilitate the unobstructed flow of all condensate.
      l. All parts shall be compatible with other single wall and double wall products of the same manufacturer.
      m. System is to be sized in accordance with the appliance manufacturer's specifications, NFPA 54-National Fuel Gas Code (ANSI Z223.1), ASHRAE recommendations, and other applicable codes.
   2. Sealant:
      a. General Electric RTV106 (aka Momentive) or Dow Corning 736 High Temperature Sealant shall be used to seal all joints on systems where the maximum flue gas temperature will not exceed 550°F. or A factory installed 550°F compatible silicone rubber gasket shall be used to seal joints.

B. Single Wall Polypropylene Vent Systems
   1. The vent shall be of the single wall, factory-built type, designed for use in conjunction with Category II, or IV condensing gas fired appliances, condensing oil fired appliances or as specified by the heating equipment manufacturer.

2. Maximum continuous flue gas temperature shall not exceed 230 degrees F (110 degrees C).
3. Vent shall be listed for a maximum positive pressure rating of 20” w.c.
4. The vent system shall be continuous from the appliance’s flue outlet to the vent termination outside the building. All systems components shall be UL/cUL listed and supplied by the same manufacturer.
5. All systems components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings required to install the vent system shall be UL/cUL listed and provided by the vent manufacturer.
6. All systems components shall include a factory- installed gasket in their female-end to render the vent air and water tight when the male/female ends are pushed together as per manufacturer’s instructions. Vent systems requiring field installed sealants or compounds shall not be acceptable.
7. Vent layout shall be designed and installed in compliance with manufacturer’s installation instructions and all applicable local codes.
8. The vent shall be constructed from Flame Resistant Polypropylene, with a min. wall thickness of:

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

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Plastic pipe may require an adapter to transition between the air inlet connection on the appliance and the plastic air inlet pipe.

C. PVC air inlet pipe should be cleaned and sealed with the pipe manufacturer’s recommended solvents and standard commercial pipe cement for the material used.

D. PVC air inlet pipe should use a silicone sealant to ensure a proper seal at the appliance connection and the air inlet cap connection. Proper sealing of the air inlet pipe ensures that combustion air will be free of contaminants and supplied in proper volume.

E. Install in accordance with NFPA 54

F. 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.

G. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

H. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

I. Install vent dampers, locating close to draft hood collar, and secured to breeching.

J. 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.

K. Level and plumb chimney and stacks.

L. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

M. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

3.02 SCHEDULES

A. Breechings, Chimneys and Stacks.
   1. Boiler: Double Wall AL29-4C.
   2. Water Heater: Single Wall Polypropylene Vent.

END OF SECTION 235100

SECTION 235216
CONDENSING BOILERS

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. Section 230913 - Instrumentation and Control Devices for HVAC.

C. Section 232114 - Hydronic Specialties.

D. Section 232123 - Hydronic Pumps.

E. Section 232500 - HVAC Water Treatment.

1.02 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for heating hot water.

1.03 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control test reports: Indicate and interpret test results for compliance with performance requirements before shipping.

D. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements.

E. Efficiency Data Points: Data shall be submitted per ASHRAE 155 Method of Testing for Rating Commercial Space Heating Boiler Systems. This data shall cover steady state thermal efficiency, part load efficiency, and idling energy input rate. Efficiency data not supported by a third party published test standard shall not be permitted.

F. Warranty: Standard warranty specified in this Section.

1.04 CLOSEOUT SUBMITTALS

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

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: The manufacturer must have been involved in the manufacture of fire tube condensing hydronic boilers for no less than 10 years. The manufacturer must be headquartered in North America and manufacture in an ASME-certified facility wholly owned by the manufacturer. The specifying engineer, contractor and end customer must have the option to visit the factory to witness test fire and other relevant procedures.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. CSD-1 Compliance: Equipment shall comply with CSD-1.

D. ICR-4 Compliance: Equipment and installation of equipment shall comply with ICR-4.

E. ANSI Z21.13/CSA Certification: Equipment shall be ANSI Z21.13/CSA certified.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.07 WARRANTY

A. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Fire-Tube Condensing Boilers:
      a. Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship.
      b. Heat exchangers/pressure vessel are warranted against thermal shock for the lifetime of the boiler.
      c. The burner shall carry a five (5) year limited warranty against defective material or workmanship from the date of shipment.
      d. All other components shall carry a one year limited warranty from date of boiler start up or 18 months from date of manufacture if start up cannot be proven.

PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Lochinvar Crest Boiler with Hellcat Combustion Technology™ as specified on Drawings.

B. AERCO

C. Fulton

D. Manufacturer shall have the capability to design, engineer, and build package systems for the above-mentioned boilers. These can include hydronic heating, domestic hot water, and pool heating applications. Design of such systems shall be collaborative between the customer and the manufacturer.

2.02 CONSTRUCTION

A. Description: Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel interior with a carbon steel shell and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 16,000 to 20,000 Btu’s per tube. The Wave Fire Tube shall be manufactured via a liquid impact process. The Wave Fire Tube shall have an OD = 1.654” and a wall thickness = 0.039”. The top and bottom tubesheets shall have a minimum thickness = ¼” (1000-2000) or 3/8” (2500 - 6000). There shall be no overlapping welds with the Wave Fire Tube to tubesheet welds. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or “O” rings in the heat exchanger design. Cast iron, aluminum, or copper tube or water tube boilers will not be accepted.

C. Condensate Collection Basin: Fully welded 316L stainless steel.

D. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.

E. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the

water side pressure drop. Pressure drop shall be no greater than 6.5 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than:

Input MBH	Water Content
999	77 gallons
1,500	94 gallons
1,999	111 gallons
2,500	157 gallons
3,000	156 gallons
3,999	201 gallons
4,999	254 gallons
6,000	304 gallons

F. Burner: Natural gas, forced draft single burner premix design. Operation of the burner shall not exceed that of 5.7% oxygen level or 40% excess air. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall be removable from the boiler without removing the gas/air manifold.

G. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Hellcat Combustion System Gas Train: The boiler shall be supplied with a dual body gas valve with regulator and shall be capable of the following minimum turndowns:

Input MBH	Turndown	Minimum Input	Maximum Input
999	20:1	50,000	999,000
1,500	25:1	60,000	1,500,000
1,999	25:1	80,000	1,999,000
2,500	20:1	125,000	2,500,000
3,000	20:1	150,000	3,000,000
3,999	20:1	200,000	3,999,000
4,999	20:1	250,000	4,999,000
6,000	20:1	300,000	6,000,000

1. Combustion system shall integrate air and gas dampers along with a variable speed fan to control fuel/air ratio via RealTime O2 Trim™.
2. Systems that rely solely on only one or two methods to adjust the fuel/air ratio shall not be permitted.

I. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision. Boilers using a pilot for ignition and/or UV scanners for flame supervision shall be deemed unacceptable.

J. High Altitude: The BOILER shall operate at altitudes above sea level. US installations above 2,000 feet shall reference NFPA 54 for de-rate information. Canadian installations above 2,000 feet shall follow all applicable local codes and regulations.

K. Casing:

1. Jacket: Heavy gauge primed and painted steel jacket with snap-in closures. Jacket panels shall be fully removal; the front door and side panels shall not require tools for removal. The jacket shall be mounted on a steel base with a minimum thickness = ¼".
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Insulation: Minimum ½ inch thick, mineral fiber insulation surrounding the heat exchanger.
4. Combustion-Air Connections: Inlet and vent duct collars.
5. Clearances: Boilers shall feature zero (0) clearance to combustibles. Boilers shall have the ability to be placed side by side in multiples with no clearance in between if necessary. Local codes should be considered.

L. Rigging and Placement: Boiler shall include lifting lugs and fork truck accessibility for rigging.

M. Characteristics and Capacities:
1. Heating Medium: Hot water.
2. Design Water Pressure Rating: 160 psi working pressure.
3. Safety Relief Valve Setting: 50 psig
4. Minimum Water Flow Rate:

Input MBH	Minimum Flow
999	18 gpm
1,500	25 gpm
1,999	25 gpm
2,500	25 gpm
3,000	25 gpm
3,999	45 gpm
4,999	50 gpm
6,000	60 gpm

N. Oxygen Sensor
1. An O2 sensor shall be standard equipment with this boiler. The O2 sensor shall be made by a top automotive supplier and is only available through Lochinvar. The O2 sensor shall be located in the combustion chamber. Boilers with O2 sensors placed elsewhere on the unit shall not be permitted. Boilers that utilize an air pump to direct combustion samples past the O2 sensor are not permitted.

2.03 TRIM

A. Safety Relief Valve:
1. Size and Capacity: 50 lb.
a. System pressures should be confirmed.
b. Custom relief valve sizes can be ordered.
2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

B. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.

C. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.

D. Condensate Trap: Factory supplied condensate trap with condensate trap blocked drain sensor.

2.04 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC."

B. Boiler controls shall feature the following standard features:

1. 10” LCD capacitive touch screen display with 1280 x 800 resolution displaying status, modulation percentage, setpoints, and sensor data at a minimum on the home screen. Additional information such as history and parameters can be accessed via the touchscreen display without the need for navigation buttons. A screen saver mode shall be available with the display.
2. Variable Speed Boiler Pump Control: Boiler may be programmed to send a 0-10V DC output signal to an ECM or VFD boiler pump to maintain a designed temperature rise across the boiler heat exchanger. The boiler shall be able to operate in this mode with a minimum temperature rise of 20 degrees F and a maximum temperature rise of 60 degrees F. Project specific temperature rise shall be ____.
3. Password Security: Boiler shall have a password security code for the Installer to access adjustable parameters.
4. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and a 4 point adjustable reset curve.
5. Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
6. Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
7. Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
8. Domestic hot water priority: Boiler shall make the domestic hot water call for heat a priority over any space heating call and adjust the boiler setpoint to the domestic hot water boiler setpoint.
9. Domestic hot water modulation limiting: Boiler may be programmed to limit the maximum domestic hot water firing rate to match the input rating of the indirect tank coil.
10. Domestic hot water night setback: Boiler may be programmed to reduce the domestic hot water tank set point during a certain time of the day.
11. PC port connection: Boiler shall have a micro USB port allowing the connection of PC boiler software.
12. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
13. Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
14. Five pump control: Boiler shall have the ability to control the boiler pump, system pump, domestic hot water pump, domestic hot water recirculation pump, and the bypass pump.
15. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
16. Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.
17. Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.
18. Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.

19. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
20. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running, recycling reporting, and ignition attempts and should be able to view on boiler screen.
21. Interior service light: Boiler shall feature an LED service light to provide additional illumination to the interior of the boiler.

C. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:
1. Lead lag: The Control module shall minimize the number of boilers firing to achieve the heating load.
2. Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
3. Front end loading: The Control modulate shall have the ability to communicate with other Lochinvar boilers featuring the SmartTouch™ and Smart System™ control platforms. This allows for a combination of units that feature condensing and non-condensing operation if so desired.
4. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.
5. Redundancy: The Control module shall have a built in feature to continue operating with follower boilers if the Lead boiler is not operational.

D. Boiler operating controls shall include the following devices and features:
1. Set-Point Adjust: Set points shall be adjustable.
2. Operating Pressure Control: Factory wired and mounted to cycle burner.
3. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
4. Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 10 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.

E. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
5. Proof of Closure Valve (FCB 6000 only): Proof of closure valve (POC) shall prevent the boiler from firing if the POC valve seat is detected open. Upon a call for heat, once the POC valve seat is proven to be closed, the pre-purge cycle will begin and the POC valve will begin to open.

6. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
7. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
8. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

F. Building Automation System Interface: Factory installed Modbus and BACnet MSTP gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.
1. BACnet IP and LonWorks gateways are available as optional equipment.

G. Software Update: The control shall have the ability to receive updates in the field without hardware component replacement. This update can be performed via USB flash drive, internet connection, or via wireless connection. This service shall be provided at no additional and/or annual cost to the owner.

H. CON•X•US Remote Connect: Integral remote connectivity technology that allows a mobile device to monitor and control boiler functionality. Internet connection is available on the Crest via Wi-Fi or hardwired Ethernet connection. This service shall be provided at no additional and/or annual cost to the owner.

I. RealTime O2 Trim™: Boiler shall provide real time trimming of O2 while the boiler is operational. Free air calibration of the sensor shall occur after every combustion cycle. The O2 value shall also auto correct for conditions such as barometric pressure, air temperature, fuel content, and altitude. O2 information shall be displayed in real time via a gauge on both the boiler touchscreen as well as the CON•X•US Remote Connect Application.
1. The following methods of fuel/air trim shall be integrated into the system:
   a. Feed Forward
      1) Temperature and Barometric pressure shall be measured to determine the appropriate atmospheric conditions present.
   b. Commissioned Trim
      1) When commissioning the unit 9 pre-set points will be fine-tuned by the installer. These settings will be used to optimize the fuel/air ratio across the operation range of the boiler. In addition, a separate ignition point will be commissioned as well to ensure proper fuel/air mix.
   c. Learned Trim
      1) As the boiler operates the controls will log the air temperature and barometric pressure along with the target fuel/air ratio. As these air temperature and barometric pressure settings reoccur the controls will initially return to the optimal setting based on its learned trim.
   d. Feed Back
      1) Once all of the above methods have taken place the O2 sensor shall provide “feedback” to confirm if the optimal fuel/air ratio has been reached.
2. The boiler shall use the direct wet O2 measurement as the feedback loop. Boilers that use a dry O2 reading or a 0-10V signal to control the fuel/air ratio are not permitted.
3. The RealTime O2 Trim is active whenever the boiler is running regardless of the time of day. Boilers that actively trim only during select periods of the day shall not be permitted.
4. Boiler shall have the ability for the user to adjust combustion system to optimal fuel/air ratio via the on-board touchscreen. Boilers that utilize an external display to calibrate the combustion system shall not be permitted.
5. Systems that utilize only a feedback operation to accurately trim the O2 shall not be permitted.

2.05 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

C. Electrical Characteristics:
   1. See Drawings
   2. Factory supplied 208V, 480V or 600V transformers are available for optional voltage.

2.06 VENTING

A. Exhaust flue must be Category IV approved PVC, CPVC, PP or stainless steel sealed vent material from one of the approved manufacturers listed in the Installation and Operation manual. Boilers exhaust vent length must be able to extend up to 150 equivalent feet.

B. Intake piping for all models must be of approved material as listed in the Installation and Operations manual. Boilers intake pipe length must be able to extend up to 150 equivalent feet.

C. Boiler venting and intake piping configuration shall be installed per one of the approved venting methods shown in the Installation and Operation manual.

D. Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.

E. Boilers using common venting must contact the factory for sizing.

F. Refer to manufacturer's Installation and Operations manual for detailed venting instructions and approved vent manufacturers.

2.07 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

EXECUTION

3.01 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in of piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.02 BOILER INSTALLATION

A. Install equipment on 6" concrete housekeeping pad.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.03 CONNECTIONS

A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

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

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required. Gas regulator shall also be installed per IOM. Manufacturer shall offer a 2 and 5 psi gas regulator offering for each boiler model.

E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting:
   1. Install flue venting kit and combustion-air intake.
   2. Connect full size to boiler connections. Comply with requirements in Division 23 Section “Breechings, Chimneys, and Stacks.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

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

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

D. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.

3. Perform field performance tests to determine capacity and efficiency of boilers.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report.
9. Document test results in a report and submit to Architect.

E. Annual Inspection/Maintenance Program
1. Manufacturer shall offer an annual inspection and maintenance program. Scope of work shall include inspecting key components, cleaning filters and burner, and reviewing findings with the property owner. Service shall be offered as an additional program.

3.05 DEMONSTRATION

A. Engage a factory representative or a factory-authorized service representative for boiler startup and to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 235216 235216

SECTION 236423
SCROLL WATER CHILLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air-cooled scroll water chillers.

1.02 RELATED REQUIREMENTS

A. Section 033000 - CAST-IN-PLACE CONCRETE: Concrete housekeeping pads.

B. Section 230513 - Common Motor Requirements for HVAC Equipment-CPL.

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

D. Section 230593 - Testing, Adjusting, and Balancing for HVAC-CPL.

E. Section 230800 - Commissioning of HVAC.

F. Section 230923 - Direct-Digital Control System for HVAC.

G. Section 230993 - Sequence of Operations for HVAC Controls.

H. Section 232113 - Hydronic Piping.

I. Section 232114 - Hydronic Specialties.

J. Section 260583 - Wiring Connections.

1.03 REFERENCE STANDARDS

A. AHRI 550/590 (I-P) - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle; 2023.

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

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 (2026).

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Architect of any major deviations from the equipment originally specified prior to ordering equipment.

1.05 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES for submittal procedures.

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

C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

D. Design Calculations:
   1. Roof Rails and Chillers: Comply with wind performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Refer to section 230550 Wind Restraint for HVAC Systems

E. Manufacturer's Certificate: Certify that components furnished but not produced by manufacturer meet or exceed manufacturer's requirements.

F. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.

G. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

H. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories; include trouble-shooting guide.

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

B. Chiller manufacturer’s plant must be ISO registered.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written installation instructions for rigging, unloading, and transporting units.

B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.08 WARRANTY

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

B. Standard Warranty (Domestic): The refrigeration equipment manufacturer’s guarantee shall be for a period of one year from date of equipment start-up but not more than 18 months from shipment. The guarantee shall provide for repair or replacement due to failure by material and workmanship that prove defective within the above period, excluding refrigerant.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Dunham Bush

B. Trane Technologies, PLC: www.trane.com/#sle.

C. York, a brand of Johnson Controls International, PLC: www.york.com/#sle.

D. Substitutions: See Section 016000 - Product Requirements.
   1. The chilled water system has been designed based on specific capacities and characteristics of equipment specified in this section and other sections.
   2. When substitution of a different manufacturer or model number is desired, submit sufficient information to demonstrate to Architect that the substitute will have the same or better performance as that specified AND that the related equipment in the system will perform acceptably with the substitute.
   3. If the related equipment must be modified to perform acceptably with the substitute, the entity proposing the substitution is responsible for all additional costs due to re-design and provision of different related equipment.

2.02 AIR COOLED SCROLL-WATER CHILLER

A. Unit Description:
   1. Provide and install as shown on the plans factory-assembled, factory-charged air-cooled scroll compressor packaged chillers in the quantity specified. Each chiller shall consist of hermetic tandem scroll compressor sets, brazed plate evaporator, air-cooled condenser section, microprocessor-based control system and all components necessary for controlled unit operation.

2. Chiller shall be functionally tested at the factory to ensure trouble free field operation

B. Design Requirements
   1. Flow Range: The chiller shall have the ability to support variable flow range down to 40% of nominal design (based on AHRI conditions).
   2. Operating Range: The chiller shall have the ability to control leaving chilled fluid temperature from 15F to 70F.
   3. General: Provide a complete scroll compressor packaged chiller as specified herein and as shown on the drawings. The unit shall be in accordance with the standards referenced in section 1.02 and any local codes in effect.
   4. Performance: Refer to the schedule of performance on the drawings. The chiller shall be capable of stable operation to a minimum percentage of full load of 17%. Performance shall be in accordance with AHRI Standard 550/590.
   5. Acoustics: Sound pressure levels for the unit shall not exceed the scheduled levels. All manufacturers shall provide the necessary sound treatment (parts and labor) to meet these levels if required. Sound data shall be provided with the quotation. Test shall be in accordance with AHRI Standard 370.

C. Chiller Components
   1. Compressor: The compressors shall be sealed hermetic, scroll type with crankcase oil heater and suction strainer. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads.
   2. Evaporator:
      a. The evaporator shall be a compact, high efficiency, dual circuit, brazed plate-to-plate type heat exchanger consisting of parallel stainless steel plates. Vent and drain connections shall be provided in the inlet and outlet chilled water piping by the installing contractor.
      b. The evaporator shall be protected with an external, electric resistance heater plate. The evaporator and suction piping to the compressors shall be insulated with 3/4” (19 mm) thick CFC and HCFC-free closed-cell flexible elastomeric foam insulation material with 100% adhesive coverage. The insulation shall have an additional outer protective layer of 3mm thick PE embossed film to provide superior damage resistance. Insulation without the protective outer film shall not be acceptable. UV resistance level shall meet or exceed a rating of ‘Good’ in accordance with the UNI ISO 4892 - 2/94 testing method. This combination of a heater plate and insulation shall provide freeze protection down to -20°F (-29°C) ambient air temperature.
      c. The water-side maximum design pressure shall be rated at a minimum of 469 psig (3235 kPa). Evaporators shall be designed and constructed according to, and listed by, Underwriters Laboratories (UL).
   3. Condenser:
      a. Condenser fans shall be propeller type arranged for vertical air discharge and individually driven by direct-drive fan motors. The fans shall be equipped with a heavy-gauge vinyl-coated fan guard. Fan motors shall be TEAO type with permanently lubricated ball bearings, inherent overload protection, three-phase, direct-drive, 1140 rpm. Each fan section shall be partitioned to avoid cross circulation.
      b. Coil shall be microchannel design and shall have a series of flat tubes containing multiple, parallel flow microchannels layered between the refrigerant manifolds. Tubes shall be 9153 aluminum alloy. Tubes made of 3102 alloy or other alloys of lower corrosion resistance shall not be accepted. Coils shall consist of a twopass arrangement. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils shall withstand 1000+ hour acidified synthetic sea water fog (SWAAT) test (ASTM G85-02) at 120°F (49°C) with 0% fin loss and develop no leaks.

4. Refrigerant Circuit: Each of the two refrigerant circuits shall include a replaceable-core refrigerant filter-drier, sight glass with moisture indicator, liquid line solenoid valve (no exceptions), expansion valve, and insulated suction line.
5. Construction: Unit formed sheet metal components shall be painted using a corrosion resistant paint system, for aesthetics and long-term durability. Paint system will include a base primer with a high-quality polyester resin topcoat. Painted galvanized parts shall be G60 or greater and finished, unabraded panel surfaces shall be capable to be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16” at 1,000 hours minimum exposure to an ASTM B117 salt spray environment.
6. Control System:
    a. A centrally located weatherproof control panel shall contain the field power connection points, control interlock terminals, and control system. Box shall be designed in accordance with NEMA 3R rating. Power and starting components shall include factory circuit breaker for fan motors and control circuit, individual contactors for each fan motor, solid-state compressor three-phase motor overload protection, inherent fan motor overload protection and two power blocks (one per circuit) for connection to remote, contractor supplied disconnect switches. Hinged access doors shall be lockable. Barrier panels or separate enclosures are required to protect against accidental contact with line voltage when accessing the control system
    b. Shall include optional single-point connection to a non-fused disconnect switch with through-the door handle and compressor circuit breakers.
7. Unit Controller:
    a. An advanced DDC microprocessor unit controller with a 7” resistive touch screen HMI provides the operating and protection functions. The controller shall take preemptive limiting action in case of high discharge pressure or low evaporator pressure. The controller shall contain the following features as a minimum:
    b. The unit shall be protected in two ways: (1) by alarms that shut the unit down and require manual reset to restore unit operation and (2) by limit alarms that reduce unit operation in response to some out-of-limit condition. Shut down alarms shall activate an alarm signal.
    c. Shutdown Alarms:
        1) No evaporator water flow
        2) Sensor failures
        3) Low evaporator pressure
        4) Evaporator freeze protection
        5) High condenser pressure
        6) Motor protection system
        7) Phase voltage protection
    d. Limit Alarms
        1) Condenser pressure stage down, unloads unit at high discharge pressure.
        2) Low ambient lockout, shuts off unit at low ambient temperatures
        3) Low evaporator pressure hold, holds stage #1 until pressure rises
        4) Low evaporator pressure unload, shuts off one compressor
    e. Analog Inputs:
        1) Reset of leaving water temperature, 4-20 mA
        2) Current Limit
    f. Digital Inputs
        1) Unit off switch
        2) Remote start/stop
        3) Flow switch

4) Ice mode switch, converts operation and setpoints for ice production
5) Motor protection

g. Digital Outputs
1) Shutdown alarm; field wired, activates on an alarm condition, off when alarm is cleared
2) Evaporator pump; field wired, starts pump when unit is set to start

h. Condenser fan control: The unit controller shall provide control of condenser fans based on compressor discharge pressure.

i. Building Automation System (BAS) Interface:
1) Factory mounted DDC controller(s) shall support operation on a BACnet® or Modbus® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.
2) BACnet IP, (Annex J)
3) The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
4) All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

j. Factory-mounted thermal dispersion type flow switch

8. Options and Accessories: The following optional items shall be furnished
a. Spring vibration isolators for field installation.
b. Strainer to be installed at the evaporator inlet and sized for the design flow rate , with perforation diameter of 0.063” with blowdown valve and Victaulic couplings (factory mounted or field installed)
c. 115V GFI convenience outlet

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on steel or concrete foundations.

C. Install units on vibration isolators.

D. Connect to electrical service.

E. Connect to chilled water piping.

F. Install a required cleanable, field-supplied strainer in the chilled water return line at the evaporator inlet per the guidelines in the installation manual.

G. Arrange piping for easy dismantling to permit tube cleaning and removal.

3.02 MANUFACTURER'S FIELD SERVICES

A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.

B. Supply initial charge of refrigerant and oil if not completely factory charged.

C. Demonstrate system operations and verify specified performance.

3.03 CLOSEOUT ACTIVITIES

A. 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.

END OF SECTION 236423

SECTION 237413
PACKAGED ROOFTOP UNITS / OUTDOOR AIR HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged roof top unit.

B. Unit controls.

C. Roof mounting curb and base.

1.02 RELATED REQUIREMENTS

A. Section 077200 - Roof Accessories: Placement and installation of factory fabricated roof mounting curbs.

B. Section 230913 - Instrumentation and Control Devices for HVAC: Control components, time clocks.

C. Section 260583 - Wiring Connections: Installation and wiring of thermostats and other controls components; wiring from unit terminal strip to remote panel.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

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. 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.

D. Design Calculations:
   1. Roof Curbs and Rooftop Air Handling Units: Comply with wind performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Refer to section 230550 Wind Restraint for HVAC Systems

E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

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

B. Packaged air-cooled condenser and air-source heat pump units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.

C. Unit shall be certified in accordance with UL Standard 60335-2-40 and CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

D. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

E. Unit shall be certified in accordance with ANSI Z21.47b/CSA 2.3b and ANSI Z83.8/CSA 2.6, Safety Standard Gas-Fired Furnaces.

F. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

G. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.

1.06 DELIVERY, STORAGE, AND HANDLING

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

B. Unit shall be shipped with doors bolted shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation. Horizontal configuration units shall include panels covering air intake and discharge openings.

C. Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

D. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation, and Maintenance manual.

1.07 WARRANTY

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

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

C. Compressors shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

D. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.

E. Economizer assembly shall carry a 5 year parts warranty from the date of original equipment shipment from the factory.

F. Polymer energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard limited parts warranty. The remaining period of the warranty shall be covered by the wheel manufacturer. The 5 year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the wheel manufacturer written instructions for Installation, Operation, and Maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the wheel manufacturer Energy Recovery Cassette Limited Warranty Certificate.

G. Aluminum Energy recovery wheel shall be covered under the standard limited parts warranty; the first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. AAON. - Basis of Design

B. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.

C. Valent..

D. Substitutions: See Section 016000 - Product Requirements.

2.02 ROOFTOP UNITS

A. General Description
   1. Packaged rooftop unit shall include:
      a. Evaporator coils
      b. Filters
      c. Supply fans
      d. Dampers
      e. Air-source heat pump
      f. Variable capacity compressors
      g. Variable speed compressors and electronic expansion valves
      h. Reversing valves
      i. Air-cooled condenser coils and condenser fans
      j. Reheat coil
      k. Gas heaters
         1) Refer to schedules
      l. Exhaust fans
      m. Energy recovery wheels
         1) Refer to schedules
      n. Unit controls
   2. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
   3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
   4. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
   5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
   6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
   7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
   8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

B. Construction
   1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
   2. Unit insulation shall have a minimum thermal resistance R-value of 16. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929-11 for a minimum flash ignition temperature of 610°F.
   3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture

accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel, and prevents exterior condensation on the panel.

4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, reheat coil, heaters, energy recovery wheels, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with bottom discharge and bottom return air openings. Openings shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall be provided with end discharge and end return air openings. Openings shall have upturned flanges of at least 1/2 inch in height around the opening.
11. Unit shall include lifting lugs on the top of the unit.
12. Unit base pan shall be provided with 1/2 inch thick foam insulation.
13. Unit base shall be fabricated of 1 inch thick double wall, impact resistant, rigid polyurethane foam panels.

C. Electrical
1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
2. Unit shall have a 10 kAIC SCCR.
3. Air-source heat pump shall include a defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation. Defrost cycle shall begin when outdoor coil temperature is below a fixed setpoint and have a fixed 10 minute run time, or end when the outdoor coil temperature is above a fixed setpoint. Defrost timer, with 30/60/90 minute selectable defrost cycle interval time, shall be factory installed in the controls compartment. During defrost cycle all compressors shall energize, reversing valve shall de-energize, and auxiliary heat shall energize.
4. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimized defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to insure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, reversing valves shall de-energize, and auxiliary heat shall energize.

5. Unit shall be provided with a factory installed and factory wired 115V, 12 amp GFI outlet disconnect switch in the unit control panel.
6. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

D. Supply Fans
1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

E. Exhaust Fans
1. Exhaust dampers shall be sized for 100% relief.
2. Fans and motors shall be dynamically balanced.
3. Unit shall include barometric relief dampers.
4. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
5. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
6. Unit shall include belt driven, unhoused, backward curved, plenum exhaust fans.
7. Unit shall include belt driven, unhoused, backward curved, plenum exhaust fans.
8. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

F. Cooling Coils
1. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
2. Coils shall have interlaced circuitry and shall be standard capacity.
3. Coils shall be 6 row high capacity.
4. Coils shall have interlaced circuitry and shall be 6 row high capacity.
5. Coils shall be hydrogen or helium leak tested.
6. Coils shall be furnished with factory installed expansion valves.

G. Refrigeration System
1. Unit shall be factory charged with R-454B refrigerant.
2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed liquid line filter driers.

7. Unit shall include a variable capacity scroll compressor on the refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.
8. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 10-100% of its capacity, and a two-stage compressor on the lag refrigeration circuit that shall modulate between two capacity settings, 67% and 100%.
9. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
10. Reheat coil shall be multi-pass and fabricated from aluminum microchannel tubes.
11. Unit shall be configured as an air-source heat pump. Refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.
12. Refrigeration circuit shall be equipped with a liquid line sight glass.
13. Refrigeration circuit shall be equipped with suction and discharge compressor isolation valves.
14. The factory installed controls shall include a 3 minute off delay timer to prevent compressor short cycling. The controls shall also include an adjustable, 20 second delay timer for each additional capacity stage to prevent multiple capacity stages from starting simultaneously and an adjustable compressor lock out.
15. Unit shall be provided with an adjustable compressor lockout.

H. Condensers
1. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
2. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
3. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
4. Coils shall be hydrogen or helium leak tested.
5. Condenser fans shall be high efficiency electrically commutated motor driven with factory installed head pressure control module. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F with adjustable compressor lockout.

I. Gas Heating
1. Refer to schedules for units with gas heating.
2. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
4. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
5. High Turndown Modulating Natural Gas Furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air

temperature setpoint shall be adjustable on the electronic controller within the controls compartment. Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet. Heat trace shall be include on the condensate drain line.

J. Filters
   1. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.
   2. Unit shall include 1 inch aluminum mesh pre filters upstream of the outside air opening.
   3. Unit shall include a clogged filter switch for the unit filters.

K. Outside Air/Economizer
   1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Unit shall include outside air opening bird screen and outside air hood. Unit, except for horizontal series, shall also include barometric relief dampers.
      a. Damper assembly shall be controlled by spring return DDC actuator.
      b. Economizer shall be furnished with a California Energy Commission Certified Title 24 Fault Detection and Diagnostic package. Economizer assembly shall carry a 5 year parts warranty from the date of original equipment shipment from the factory.
   2. Outdoor Airflow Monitoring
      a. Unit shall include outside airflow measuring station and airflow signal processor that communicates directly with the factory provided control systems or can also be used with customer provided controls with a 0-10 VDC output signal. LonTalk and BACnet may also be available for some applications. Monitoring size is dependent on the cfm.

L. Energy Recovery
   1. Unit shall contain a factory mounted and tested energy recovery wheel(s). The energy recovery wheel(s) shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
   2. Wheel frame shall slide out for service and removal from the cabinet.
   3. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
   4. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.
   5. Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard limited parts warranty. The remaining period of the warranty shall be covered by the wheel manufacturer. The 5 year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the wheel manufacturer written instructions for Installation, Operation, and Maintenance have

been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the wheel manufacturer Energy Recovery Cassette Limited Warranty Certificate.

6. Unit shall include 2 inch thick, pleated panel outside air filters with an ASHRAE MERV rating of 8, upstream of the wheels.
7. Hinged service access doors shall allow access to the wheel(s).
8. Unit shall include energy recovery wheel defrost control which includes an adjustable temperature sensor and timer wired to periodically stop the wheel rotation, which allows the warm exhaust air to defrost the wheel.
9. Polymer Energy Recovery Wheels
    a. Shall be provided with removable energy transfer segments. Cassette frame and structural components shall be constructed of G90 galvanized steel for corrosion resistance. Wheel structure shall consist of a welded hub, spoke and continuous rolled rim assembly of stainless steel, and shall be self-supporting without energy transfer segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
    b. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive.
    c. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
10. Aluminum Energy Recovery Wheels
    a. Unit shall contain a factory mounted and tested monolithic aluminum energy recovery wheel with an inverter duty motor and a durable segmented link drive belt composite. Wheel frame shall be constructed with prime G90 hot-dip galvanized steel tested for corrosion resistance of 400 hours of salt spray.
    b. Aluminum Energy recovery wheel shall be covered under the standard limited parts warranty; the first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts.
    c. Total energy recovery wheels shall be made of corrugated aluminum with a 3A molecular sieve desiccant coating. Coated segments shall be cleanable with hot water or compressed air without degrading the latent recovery.
11. Cross-Flow Fixed Plate Energy Recovery
    a. Unit shall contain a factory installed and tested cross-flow fixed plate energy recovery heat exchanger with no moving parts and unique rectangular flute design for low pressure drop values and enhanced performance.
    b. Cross-flow fixed plate energy recovery heat exchanger shall be listed in the AHRI Certified Product Directory and bear the AHRI Certified Product Seal.Sensible, latent and total effectiveness along with pressure drop, EATR and OACF rating shall be clearly documented with performance tests conducted in accordance with ASHRAE

Standard 84-91 and ARI Standard 1060-2011.Performance data derived from laboratory testing on heat exchanger conditions is in accordance with ASHRAE Standard 84-1991 “method of testing air-to-air heat exchangers”.Performance shall be rated in accordance with AHRI testing procedures.

c. The cross-flow fixed plate energy recovery heat exchanger shall be an Underwriters Laboratories Recognized Component for electrical and fire safety.
d. Unit shall include 2 inch thick, pleated panel outside air filters with an ASHRAE MERV rating of 8, upstream of the heat exchanger.
e. Enthalpy cross-flow fixed plate energy recovery heat exchanger shall transfer both sensible and latent energies between exhaust and outside air streams in a cross-flow arrangement.The enthalpy fixed plate exchanger media shall be impregnated with a RC134 polymeric desiccant. The hydroscopic polymer shall exchange water by direct vapor transfer using molecular transport without the need of condensation.Desiccant shall be bactericide. The enthalpy fixed plate exchanger shall be capable of operating at temperatures between -40°F and 140°F.The enthalpy fixed plate exchanger shall be able to withstand, without more than 10% increase of pressure drop, pressure differential of at least 5” w.g. It shall withstand pressure differential of 10” w.g. without permanent deformation.The enthalpy cross-flow fixed plate energy recovery heat exchanger shall have both its membrane and complete assembly certified per the UL723 standard (fire and smoke development). Exhaust Air Transfer ratio (EATR), shall be less than 3%.

12. Controls
    a. Field Installed DDC Controls by Others.
        1) Controls shall be field provided and field installed by others.
        2) Isolation relays shall be factory installed.
13. Accessories
    a. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.
    b. Unit shall be provided with a high condensate level switch that shuts down the unit when a high water level is detected in the drain pan.

2.03 CURBS

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

B. Solid bottom curb shall be factory assembled and fully lined with curb rated 1 inch fiberglass insulation and include a wood nailer strip. (Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

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.

3.03 SYSTEM STARTUP

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

END OF SECTION 237413

SECTION 238126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outdoor Air-Source Heat Pumps

B. Outdoor Unit Accessories

C. 4-Way Indoor Ceiling Cassette Units

D. High-Wall Indoor Units

1.02 RELATED REQUIREMENTS

A. Section 230913 - Instrumentation and Control Devices for HVAC: Thermostats, humidistats, time clocks.

B. Section 233100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2027.

1.04 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES 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. Design Data: Provide releasable refrigerant charge calculations

F. Design Calculations:Roof Rails and Rooftop Heat Pumps: Comply with wind performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Refer to section 230550 Wind Restraint for HVAC Systems

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

H. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

I. Project Record Documents: Record actual locations of components and connections.

1.05 QUALITY ASSURANCE

A. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

D. A full refrigerant charge for the condensing unit only shall be provided. Additional refrigerant is required based on diameters and lengths of system liquid refrigerant lines and indoor equipment model and quantity.

E. Service and installation manuals must be readily available on the manufacturer's website at all times without entering a username and password.

1.06 WARRANTY

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

B. If a part or compressor fails due to manufacture defect, replace defective part or compressor without charge for a period of 5 years for parts and 7 years for the compressor from the original date of installation. This limited warranty does not include labor. Extended warranties exist for certain products with registration where allowed for parts warranties up to 10 years and compressor warranties up to 10 years. Conditions apply. See manufacturer's warranty terms for full details and conditions available on their website.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Samsung

B. Mitsubishi-Trane

C. Fujitsu

D. Substitutions: See Section 016000 - Product Requirements.

2.02 OUTDOOR UNITS

A. General:
1. The heat pump outdoor unit shall be capable of guaranteed operation in cooling mode below 23°F (-5°C) down to 0°F (-18°C) outside ambient temperature with the addition of factory provided front and rear wind baffles (accessory).
2. The heat pump outdoor unit shall auto-restart after power loss.
3. The heat pump outdoor unit shall have a high pressure safety switch, fuse, over-current protection, over-voltage protection, temperature limit protection logic, and compressor overload sensing.
4. The heat pump outdoor unit shall have snow accumulation prevention option setting to prevent snow drifting against an idle outdoor unit.
5. The heat pump outdoor unit shall have the capability to be configured as heating/cooling, cooling only, or heating only via outdoor unit option setting.

B. Refrigerant Piping:
1.
2. Installed refrigerant pipe length and vertical separation shall be within the published manufacturer's specifications.

C. Unit Cabinet:
1. The chassis shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

D. Fan:
1. The outdoor unit shall be furnished with axial fan(s) with BLDC motor(s).
2. All fan motors shall have inherent protection, thermal protection, and have permanently lubricated bearings, and be completely variable speed.
3. All fan motors shall be mounted for quiet operation.
4. All fans shall be provided with a raised guard to prevent contact with moving parts.
5. The outdoor unit shall have horizontal discharge airflow.

E. Refrigerant:
   1. The system shall use R-32 refrigerant..
   2. Additional refrigerant may be required. Additional charge is based on installed refrigerant pipe diameters and lengths.
   3. The unit shall include an R-32 alarm output plug for notification of R-32 leak detection when a supported indoor unit's refrigerant leak detector detects a refrigerant leak (only applies when the indoor unit has a R-32 leak detector).

F. Coil:
   1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
   2. The coil shall be protected with an integral metal guard.
   3. The Heat Pump condensing unit salt spray test method: ASTM B117 - the heat exchanger showed no unusual rust or corrosion development to 2,280 hours.

G. Compressor:
   1. The compressor shall be an inverter driven, DC voltage, twin BLDC rotary compressor.
   2. A crankcase heating device shall be factory mounted in/on the compressor.
   3. The heat pump outdoor unit compressor shall have a soft-start function to reduce electricity demand during system start and to increase compressor reliability.
   4. The compressor will be equipped with an internal thermal overload.
   5. The compressor shall be mounted to avoid the transmission of vibration.

H. Electrical:
   1. The outdoor unit shall be controlled by integral microprocessors.
   2. The outdoor unit shall provide power to the indoor unit with 14 AWG X 3 power wire (2 X high voltage wires, 1 X ground). The power wire shall be run from the condensing unit to indoor unit.

2.03 OUTDOOR UNIT ACCESSORIES

A. Front Wind Baffles
   1. General:
      a. The outdoor unit(s) shall have a front wind baffle provided by the HVAC manufacturer.
      b. The front wind baffle is designed to be placed on fan discharge side (front).
      c. Only a front shield is required for applications where the outdoor unit is adjacent to a structure that would protect the intake side from prevailing wind. Applications without this protection would require a back shield (ex: roof top).
      d. The wind baffle material shall be powder coated, galvanized steel.

B. Back Wind Baffles
   1. General:
      a. The outdoor unit(s) shall have a front wind baffle provided by the HVAC manufacturer.
      b. The back wind baffle is designed to be placed on the coil intake side of the unit (back).
      c. Note: This back shield is only required for applications where the outdoor unit is not adjacent to a structure that would protect the intake side from prevailing wind (ex: roof top).
      d. The wind baffle material shall be powder coated, galvanized steel.

C. Hail Guard Kits
   1. General
      a. The outdoor unit(s) shall have hail guards provided by the HVAC manufacturer.

b. The hail guard kit shall include a rear guard and a side guard designed to protect the condenser coil while providing sufficient airflow for optimal unit performance.
c. The wind baffle material shall be powder coated, galvanized steel.

2.04 4-WAY CEILING CASSETTE INDOOR UNIT

A. Indoor Unit:
1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air (Nitrogen gas) before shipment from the factory.
2. The indoor unit shall feature comfort humidity control. Utilizing an integral humidity sensor, the system optimizes the indoor unit coil temperature according to the dew point, maximizing energy savings while still providing space dehumidification and occupant comfort.
3. The indoor unit shall include an internal condensate pump with check-valve as standard with a maximum vertical lift of 29 inches from the bottom of the unit.
4. The indoor unit shall have an integral condensate float switch to disable the unit in the event of condensate overflow.

B. Unit Cabinet:
1. The cabinet shall be space-saving ceiling-recessed cassette.
2. Service of electronics, high and low voltage connection, condensate pump, fan, fan motor, sensors, condensate pan, and other components shall be accessible from the bottom of the cassette unit not requiring access from the sides of the unit.
3. Construction shall be HIPS chassis with a galvanized steel frame and fascia panel certified to UL94 V0.
4. Each corner portion of the panel cabinet is detachable, which gives easy access to adjust the height.
5. The cabinet shall have provisions for a field installed, filtered, outside air intake. A booster fan is necessary. A 12V DC relay terminal is available to control a booster fan (with separate PCB connector).
6. Branch ducting shall be allowed from cabinet, available on 2 sides to condition an adjacent area within a single room.
7. The cabinet shall have a fresh air intake opening to accommodate the introduction of fresh air into the space.
8. The indoor unit fascia panel shall have LED indicator lights on the front and an IR receiver for wireless controller use.

C. Fan:
1. The indoor fan assembly shall be a turbo fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of three (3) speeds, Low, Mid, and High. Auto fan speed setting is available.
4. The auto swing air outlet vanes (4) shall be capable of automatically swinging up and down for uniform air distribution.
5. The supply air vanes shall have independent control capability (32° – 65° control range) adjustable with optional wireless or wired controllers.

D. Filter:
1. Return air shall be filtered by means of a long-life washable permanent filter included with fascia panel.

E. Coil:

1. The indoor coil shall be of nonferrous construction with slit fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The coil fins are coated with hydrophilic paints.
7. The condensate lift mechanism shall be able to raise drain water 29 inches above the condensate pan with built in check valve and float switch.
8. Both refrigerant lines to the indoor unit shall be insulated.

F. Electrical:
1. The control circuit between the indoor unit and the outdoor unit shall be 0.5VDC - 7VDC completed using stranded, annealed copper conductor, two-core, 16 AWG cable to provide total integration of the system

G. Controls:
1. The indoor unit shall have the capability to be controlled via local wired controllers, wireless controllers, multi-unit Wi-Fi adapters, single unit Wi-Fi adapters, and central control options provided by the HVAC manufacturer.
2. This unit shall use controls provided by the HVAC manufacturer to perform functions necessary to operate the system. Please refer to the “Controls” section of this guide specification for details on controllers and other control options.
3. The indoor unit shall feature a Dual Set point function that allows users to set separate heating and cooling set temperatures using supported local wired controller and central control options. Dual set temperature allows the user to specify a deadband where the unit will not heat or cool when room temperature is between the heating and cooling set temperatures. Dual set temperature can be used with heat pump or heat recovery systems.

2.05 HIGH-WALL

A. Indoor Unit:
1. WindFree™* mode only operates in Cooling and Dry modes.
2. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board and fan motor.
3. The indoor unit shall provide a simple connection for field-provided overflow detection switches to disable the unit via dry contact and display the error status.

B. Unit Cabinet:
1. The casing shall have a gloss white finish, HIPS chassis certified to UL94 V0.
2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and four (4) directions for draining shall be standard.
3. Drain hose shall be on the right-hand side of the drain pan (when facing the front) as standard with optional left-hand side connection.
4. There shall be a separate galvanized steel mounting plate which secures the unit firmly to the wall.
5. The indoor unit shall have easy-access pipe and drain connections via access panel on front of unit for easier installation and service allowing maintenance without pulling the unit out from the wall thus preventing property damage.
6. Two digit, 7-segment display on the front of the unit, shall provide unit operation, temperature, and error status.

C. Fan:
1. The indoor fan assembly shall be a cross-flow fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.

3. Motorized air sweep louvers shall provide automatic change in airflow by directing the air up and down and left to right to provide uniform air distribution.
4. The indoor fan shall consist of three (3) speeds, High, Mid, and Low. Auto fan speed setting is available.

D. Filter:
1. Return air shall be filtered by means of a pleated, easily removable, washable filter.

E. Coil:
1. The indoor coil shall be of nonferrous construction with slit fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The coil fins are coated with hydrophilic paints.
7. Both refrigerant lines to the indoor unit shall be insulated.

F. Electrical:
1. The control circuit between the indoor unit and the outdoor unit shall be 0.5VDC - 7VDC completed using stranded, annealed copper conductor, two-core, 16 AWG cable to provide total integration of the system

G. Controls:
1. The indoor unit shall have the capability to be controlled via local wired controllers, wireless controllers, multi-unit Wi-Fi adapters, and central control options provided by the HVAC manufacturer.
2. This unit shall use controls provided by the HVAC manufacturer to perform functions necessary to operate the system. Please refer to the “Controls” section of this guide specification for details on controllers and other control options.
3. The indoor unit shall feature a Dual Set point function that allows users to set separate heating and cooling set temperatures using supported local wired controller and central control options. Dual set temperature allows the user to specify a deadband where the unit will not heat or cool when room temperature is between the heating and cooling set temperatures. Dual set temperature can be used with heat pump or heat recovery systems.

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.

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 238126.13

SECTION 238200
CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic or steam finned tube radiation.

B. Hydronic or steam unit heaters.

C. Hydronic or steam cabinet unit heaters.

D. Fan-coil units.

E. Duct-mounted coils.

F. Induction units.

1.02 RELATED REQUIREMENTS

A. Section 230513 - Common Motor Requirements for HVAC Equipment-CPL.

B. Section 230716 - HVAC Equipment Insulation-CPL.

C. Section 230719 - HVAC Piping Insulation-CPL.

D. Section 230913 - Instrumentation and Control Devices for HVAC.

E. Section 230993 - Sequence of Operations for HVAC Controls.

F. Section 232113 - Hydronic Piping.

G. Section 232114 - Hydronic Specialties.

H. Section 233100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

B. AHRI 440 - Performance Rating of Room Fan-Coils; 2008.

C. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.

D. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.

E. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2026).

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; 2027.

I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.04 SUBMITTALS

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

B. Product Data: Provide typical catalog of information including arrangements.

C. Shop Drawings:
   1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
   2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

D. Verification Samples: For each finish product specified, color chip representing actual product in color and texture.

E. Manufacturer's Instructions: Indicate installation instructions and recommendations.

F. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

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

PART 2 PRODUCTS

2.01 HYDRONIC FINNED TUBE RADIATION

A. Manufacturers:
1. Modine Manufacturing Company; _____: www.modineHVAC.com/#sle.
2. Zehnder Rittling; _____: www.rittling.com/#sle.
3. Sterling
4. Substitutions: See Section 016000 - Product Requirements.

B. Required Directory Listing: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.

C. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

D. 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 at least 3 feet on center maximum.

E. Finish: Factory applied baked enamel of color as selected.

F. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.

G. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

2.02 HYDRONIC UNIT HEATERS

A. Manufacturers:
1. Modine Manufacturing Company; _____: www.modineHVAC.com/#sle.
2. Sterling Hydronics, a Mestek Company; _____: www.sterlingheat.com/#sle.
3. Zehnder Rittling;[____]: www.rittling.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

C. Perform factory run test under normal operating conditions, water, and steam flow rates.

D. 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.

E. Finish: Factory applied baked enamel of color as selected.

F. 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.

G. Air Outlet: Adjustable pattern diffuser on vertical projection models and two- or four- way louvers on horizontal projection models.

2.03 HYDRONIC CABINET UNIT HEATERS

A. Manufacturers:
1. Modine Manufacturing Company; _____: www.modineHVAC.com/#sle.
2. Sterling Hydronics a Mestek Company; _____: www.sterlingheat.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.

B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.

C. 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.

D. Cabinet: Minimum 16 gauge, 0.0598 inch thick sheet steel front panel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.

E. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.

F. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

G. Motor: Electronically commutated high-efficiency, programmable brushless DC motor; resiliently mounted on motor board. Shaded pole motors are not acceptable. Single speed motors are not acceptable. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.04 FAN-COIL UNITS

A. Manufacturers:
1. Horizontal Cabinet:
2. Horizontal Uncased:
a. Magicaire
b. Daikin Applied; _____: www.daikinapplied.com/#sle.
c. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
d. Price
e. Substitutions: See Section 016000 - Product Requirements.

B. Performance Data and Safety Requirements:
1. Unit capacities certified in accordance with AHRI 440.
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 purpose indicated.
3. Insulation to comply with NFPA 90A requirements for flame spread and smoke generation.

4. Equipment wiring to comply with requirements of NFPA 70.

C. Required Directory Listings: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

D. Coils:
1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
2. Water Coil: Suitable for working temperatures not less than 200 degrees F.
3. Provide drain pan under cooling coil easily removable for cleaning.

E. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.

F. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

G. Motor: Electronically commutated high-efficiency, programmable brushless DC motor; resiliently mounted on motor board. Shaded pole motors are not acceptable. Single speed motors are not acceptable. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Controls:
1. Provide units with control valves furnished by the automatic temperature controls manufacturer.
2. Fan Coil Unit Manufacturer's Controls:
   a. Disconnect switch.
3. Controls Interface:
   a. Relay board.

2.05 DUCT-MOUNTED COILS

A. Water Coils:
1. Manufacturers:
   a. Aerofin Corporation; _____: www.aerofin.com/#sle.
   b. USA Coil & Air; _____: www.usacoil.com/#sle.
   c. Substitutions: See Section 016000 - Product Requirements.
2. Coils rated and tested in accordance with AHRI 410.
3. Tubes: Material to consist of seamless copper, mechanically expanded or tension wound to fins; appropriate tube joining methods based on tube material.
4. Fins: Material to consist of aluminum or copper, continuous plate type with full fin collars or individual helical finned tube type wound under tension.
5. Casing: Heavy gauge galvanized steel with mounting holes, including intermediate tube supports if required by coil design and length.
6. Headers (Manifolds): Construct of seamless copper pipe, cast iron, or nonferrous material with tube connection appropriate to header material provided.
7. Acceptable Factory Testing Methods:
   a. Perform hydrostatic testing for coils with removable headers in accordance with approved shop drawings and normally accepted means and methods.

2.06 INDUCTION UNITS

A. Manufacturers:
1. Carson Solutions
2. Price Industries; _____: www.price-hvac.com/#sle.
3. FläktGroup Semco, LLC; _____: www.semcohvac.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Perform factory run test under normal operating conditions and water flow rates.

C. Hydronic Control Air Terminals:
   1. Base Unit Assembly:
      a. Air Inlet.
      b. Air plenum.
      c. Hydronic and Electric coils.
      d. Non-Drainable condensate pan.
   2. Under-Window Enclosures:
      a. Side-Fed: Complete with knockout.
   3. Enclosure and Panel Sections: Minimum 0.0478 inch thick, cold-rolled steel with baked enamel finish.
   4. Air Plenum:
      a. Galvanized steel construction, acoustically and thermally insulated internally with neoprene-coated fiberglass.
      b. Suitable for ducted, primary air supply connections and containing air balancing damper arranged for independent, manual adjustment of primary air flow.
      c. Where required, provide recovery stack and outlet collar of cold-rolled steel, painted black finish.
   5. Hydronic Coil Assembly:
      a. One, 2-pipe, 2-row coil(s) with copper tubing, mechanically expanded into aluminum plate fins.
      b. Coil suitable for working pressures up to 250 psig.

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.

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. Fan-Coil Units:
   1. Install as indicated.

H. Units with Hydronic Coils:

1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.
2. If not easily accessible, extend air vent to exterior surface of cabinet for ease of servicing.
3. Provide float operated automatic air vents with stop valve for cabinet unit heaters, fan coil units, and unit heaters.

I. Units with Cooling Coils: Connect drain pan to condensate drain.

J. 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. See Section 233100.
2. Coil Safeguards:
   a. Protect coils to prevent damage to flanges and fins.
   b. Comb out damaged fins.
3. Make connections to hydronic and steam coils with unions and flanges.
4. 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.

3.03 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.

3.04 PROTECTION

A. Provide finished cabinet units with protective covers during the balance of construction.

END OF SECTION 238200

SECTION 238214
CHILLED BEAMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Active chilled beams.

1.02 RELATED REQUIREMENTS

A. Section 095800 - Integrated Ceiling Assemblies.

B. Section 230716 - HVAC Equipment Insulation-CPL.

1.03 REFERENCE STANDARDS

A. DIN EN 15116 - Ventilation in Buildings - Chilled Beams - Testing and Rating of Active Chilled Beams; 2008.

1.04 SUBMITTALS

A. See Section 013300 - SUBMITTAL PROCEDURES for submittal procedures.

B. Product Data: Provide catalog page, brochure, or flyer listing capacities and features.

C. Shop Drawings:
   1. Indicate coil and frame configuration, weights, dimensions, materials, rows, connections, and rough-in dimensions.
   2. Performance data, including air flow, water flow, air-side pressure drop, height allowance, water pressure drop, noise levels, and air velocities.
   3. Construction details denoting materials of construction and fastening methods.

D. Manufacturer's Instructions: Indicate installation instructions and recommendations.

E. Operation and Maintenance: Include manufacturer's literature with operating instructions, service representative, maintenance procedures, and parts data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carson Solutions

B. Price Industries; _____: www.price-hvac.com/#sle.

C. FläktGroup Semco, LLC; _____: www.semcohvac.com/#sle.

2.02 ACTIVE CHILLED BEAMS

A. Factory tested in accordance with DIN EN 15116.

B. Cooling/Heating Coil Assembly:
   1. Maximum Waterside Velocity: 4 ft/sec.
   2. Coil:
      a. Type: Linear with 2-way air discharge and two pipe cooling/heating service.
      b. Two row seamless copper tube coil with extruded aluminum fins at a rate of 10 per inch.

C. Dimensions: As indicated on Drawings.

D. Acoustical:
   1. Maximum Sound Level: As indicated on drawings.
   2. Size plenum air nozzles or slots to provide optimum air performance with a low noise level.

E. Casing:
   1. Finish:

a. Interior Casing Components: Factory applied white paint.
b. Exterior Face and Frame: Factory applied polyester epoxy powder coat, color as chosen by Architect.

2. Insulation: In compliance with Section 230716.

F. Mounting: As indicated on Drawings, coordinated with Section 095800.

G. Accessories:
1. Isolation: Supply and return flow ball valves as indicated on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are suitable for installation.

B. Verify that field measurements and locations are as indicated on Drawings.

3.02 INSTALLATION

A. Install in accordance with manufacturer's recommendations and clearances.

B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.

C. Support units from upper structure avoiding damage to equipment or finishes.

D. Active Beams: Provide a primary air connection to plenum inlet with minimum length of 8 inches using hard duct and less than 5 ft using flexible duct. Then mount averaging flow sensor on the hard duct side observing manufacturer recommended upstream and downstream requirements.

E. Vacuum clean coils and flush thoroughly inside of units to flush any impurities and residues prior to making final waterside connections.

F. Connect supply and return water service hoses to respective piping as applicable. Include isolation, balancing and control valves with other fittings and other piping specialties as indicated on Drawings.

G. Adjusting: Use plenum static pressure readings against manufacturer calibration chart to adjust primary airflow as other measuring methods will not work.

3.03 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. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

END OF SECTION 238214

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 VIBRATION ISOLATION

A. Vibration isolators shall prevent, as far as practicable, transmission of vibration, noise or hum to any part of building.

B. Design isolators to suit vibration frequency to be absorbed; provide isolator units of area, distribution to obtain proper resiliency under machinery load, impact.

C. Wiring and other electrical connections to equipment mounted on vibration isolators; made flexible with minimum 180 degree loop of "greenfield" in order to avoid restraining equipment and short circuiting vibration isolator.

1.12 BALANCED LOAD

A. It is intended that design and features of the work as indicated will provide balanced load on the feeders and main service. Contractor shall provide material and installation to provide this balance load insofar as possible.

B. Contractor shall take current and voltage measurements at all panels of at least 1/2 hour. Reconnections of loads shall be made when deemed necessary by the Engineers.

1.13 JOB CONDITIONS

A. Examine site related work and surfaces before starting work of any Section. Failure to do so shall in no way relieve the Contractor of the responsibility to properly install the new work.
   1. Report to the Engineer, in writing, conditions, which will prevent proper provision of this work ten (10) days prior to bid date, in time for an addendum to be issued .
   2. Beginning work of any Section without reporting unsuitable conditions to the Engineer constitutes acceptance of conditions by the Contractor.
   3. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.
   4. The Contractor is responsible for performing routine maintenance and cleaning of any existing equipment where he is making connections to new work and to the building where his work adds debris.

B. Connections to existing work:
   1. Install new work and connect to existing work with minimum interference to existing facilities.
   2. Provide temporary shutdowns of existing services only with written consent of Owner at no additional charges and at time not to interfere with normal operation of existing facilities.
   3. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
   4. Do not interrupt alarm and emergency systems.
   5. Connect new work to existing work in neat and acceptable manner.
   6. Restore existing disturbed work to original condition including maintenance of wiring and continuity as required. Replace damaged or rusted conduit to which new equipment is being installed and connected.

C. Removal and relocation of existing work.
   1. Disconnect, remove or relocate electrical material, equipment and other work noted and required by removal or changes in existing construction.
   2. Provide new material and equipment required for relocated equipment.
   3. Disconnect load and line end of conductors feeding existing equipment.
   4. Remove conductors from existing raceways to be rewired.
   5. Remove conductors and cap outlets on raceways to be abandoned.
   6. Cut and cap abandoned floor raceways flush with concrete floor or behind walls and ceilings.
   7. Dispose of removed raceways and wire.
   8. Dispose of removed electrical equipment as directed by Owner. The Owner shall provide a list of equipment of the Contractor of equipment to be delivered to the Owner.

1.14 SPECIAL TOOLS AND LOOSE ITEMS

A. Furnish to Owner at completion of work:
   1. One set of any special tools required to operate, adjust, dismantle or repair equipment furnished under any section of this Division.

2. "Special Tools": Those not normally found in possession of mechanics or maintenance personnel.
3. Keys
4. Redundant components and spare parts.

B. Deliver items to Owner and obtain receipt prior to approval of final payment.

1.15 REVIEW OF CONSTRUCTION

A. Work may be reviewed at any time by representative of the Engineer.

B. Advise Architect and Engineer that work is ready for review at following times:
1. Prior to backfilling buried work.
2. Prior to concealment of work in walls and above ceilings.
3. When all requirements of contract have been completed.

C. Neither backfill nor conceal work without Engineer's consent.

1.16 SHOP DRAWING SUBMITTALS

A. Submit required shop drawings, samples and product information in accordance with Division 1, requirements and as required in the various sections of these specifications.

B. Submittals shall show evidence of checking by the Contractor for accuracy. Product information (catalog sheets) shall indicate complete catalog number, color, accessories, etc., as well as, name of manufacturer and local distributor or manufacturer's representative.

C. Submit for review detailed coordination drawings 3/8" or larger scale plans for all major electrical equipment and any areas of conflicts by drafting location of equipment, lighting fixtures, cable trays and conduits larger than 1-1/2" trade size. Contractor shall refer to Division 1 for preparing coordination drawings.

D. Incomplete submittals will be rejected.

E. Additionally, the Contractor will submit data on the following:
1. All electrical equipment including all panelboards and switching devices (disconnects, switches, occupancy sensors, etc.).
2. Fire stop seals used for wall penetrations.
3. Any proposed variation in specified wiring plans and circuitry.
4. All special items and panels, made or constructed specifically for this project, including wiring diagrams, component layout and component data or materials list.
5. All settings of installed equipment, such as overcurrent protection, overload settings, temperature settings, time settings, etc. This includes equipment provided by other contractors or subcontractors and connected and tested by this Contractor.

F. All submittals of NON SPECIFIED equipment and components will be reviewed. It is the submitting Contractor's responsibility to prove compliance and not the Architect/Engineer to prove non-compliance. The submitting Contractor will be charged the prevailing wage of the reviewing Engineer for all submittals requiring over one (1) hour to review that were not originally specified.

G. It is the Contractor's responsibility to provide submittals in an organized and timely manner so as not to delay the project schedule and hamper the work of other trades.

1.17 OPERATING INSTRUCTIONS

A. It shall be the Contractor's responsibility to insure that the Owner's representative is given adequate instruction on the operation of all equipment prior to final payment.

1.18 TEMPORARY POWER

A. The Contractor shall provide all temporary power to all trades throughout all phases of construction throughout the duration of this project. This will include but not be limited to

temporary lighting, power outlets, temporary elevator operation, controls for temporary heating, and job trailers. Contractor shall be responsible for providing temporary power via adjacent building(s) and/or a temporary diesel fired generator and associated fuel costs. Contractor shall coordinate temporary power source with project manager prior to demolition. Contractor is responsible for all costs associated with temporary power.

PART 2 PRODUCTS

2.01 MATERIALS

A. All materials and equipment shall be new and as specified or of equal or better quality.

B. Basic hardware and miscellaneous items shall meet existing trade standards of quality and shall carry UL or FM listings where applicable.

C. All equipment supplied shall be the standard equipment of the manufacturer.

D. Multiple items such as panelboards, wiring devices, switches, breakers, raceways, etc., shall be from the same manufacturer.

E. Drawings and specifications are based on specific manufacturer's equipment. Therefore, the Contractor shall assume all responsibility, cost and coordination involved in making any necessary revisions to apply another manufacturer's equipment, even though it may be approved as an "equal" item by the Engineer.

PART 3 EXECUTION

3.01 COORDINATION OF WORK

A. All work shall be executed in accordance with recognized standards of workmanship. All work shall be installed in a neat and orderly manner.

B. The Contractor shall exchange information with other Contractors and the Owner in order to insure orderly progress of the work.

C. The Contractor must contact the Owner's representative and schedule all work ten (10) days prior to start.

D. The Contractor shall check for possible interference before installing any items. If any work is installed, and later develops interference with other features of the design, the Contractor will be responsible to make such changes to eliminate the interference.

3.02 CEILING REMOVAL

A. Existing ceilings which must be removed for the installation of new work or demolition of existing conditions shall be done by the Contractor. No ceiling shall be removed without prior approval of the Owner. Ceilings which must be removed shall be restored to their original condition as soon as practical and prior to final payment.

B. The removed tile of lay-in type ceilings shall be stored either in the ceiling space or at a designated space in the building. No tiles shall be stored in the occupied space.

C. The Contractor shall take all necessary precautions to prevent damage to the existing ceilings. All damaged ceilings shall be replaced with new ceiling construction to match the existing and to the Owner's satisfaction.

END OF SECTION 260010

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SECTION 260513
MEDIUM-VOLTAGE CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Medium voltage cable.

B. Cable accessories.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

A. IEEE 48 - IEEE Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV; 2020.

B. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.

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.

1.04 SUBMITTALS

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

B. Product Data: Provide for cable, terminations, and accessories.

C. Obtain approval by Con Edison prior to submittal.

D. Project Record Documents: Record actual sizes and locations of cables.

E. Certificate of Compliance: Indicate approval of installation by Con Edison Utility.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles of Project.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MEDIUM-VOLTAGE CABLE

A. Manufacturers:
   1. Okonite: www.okonite.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Medium Voltage Cable: NEMA WC 70 rubber insulated cable.
   1. Voltage: 15 kV, grounded.
   2. Conductor: #2 Copper, 7-wire compressed or concentric round stranding, with 15 mils conductor shield, 220 mils cross linked polyethylene insulation, 30 mils insulation shield

and 10 #14 AWG copper concentric neutral applied spirally around the cable with a 55 mils jacket applied over the neutral conductor.

2.02 CABLE ACCESSORIES

A. Manufacturers:
   1. 3M: www.3m.com/#sle.
   2. TE Connectivity; Raychem Products: www.te.com/#sle.

B. Cable Terminations: IEEE 48, Class 2 porcelain insulator cable terminator in kit form.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conduit, duct, trench, or manholes are ready to receive cable.

B. Verify that field measurements are as indicated.

C. Verify routing and termination locations of cable bank prior to rough-in.

D. Cable routing is shown in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 PREPARATION

A. Use swab to clean conduits before pulling cables.

3.03 INSTALLATION

A. Avoid abrasion and other damage to cables during installation.

B. Use suitable lubricants and pulling equipment.

C. Sustain cable pulling tensions and bending radii below recommended limits.

D. Ground cable shield at each termination and splice.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements, for additional requirements.

B. Inspect exposed cable sections for physical damage.

C. Inspect cable for proper connections as indicated.

D. Inspect shield grounding, cable supports, and terminations for proper installation.

E. Inspect and test in accordance with NETA ATS, except Section 4.

3.05 PROTECTION

A. Protect installed cables from entrance of moisture.

END OF SECTION 260513

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. Photovoltaic wire.
D. Wiring connectors.
E. Electrical tape.
F. Heat shrink tubing.
G. Oxide inhibiting compound.
H. Wire pulling lubricant.
I. Cable ties.
J. 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 2018).
B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).
C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.
F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2020.
G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 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.

S. UL 4703 - Standard for Photovoltaic Wire; 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, above accessible ceilings, and under raised floors 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. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      c. 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 PHOTOVOLTAIC WIRE

A. Manufacturers:
1. Service Wire Co; ServiceSolar: www.servicewire.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. Description: Sunlight-resistant, single-conductor, insulated photovoltaic wire listed and labeled as complying with UL 4703; specifically designed for interconnection wiring of photovoltaic power systems in accordance with NFPA 70.

C. Conductor Stranding: Stranded.

D. Insulation Voltage Rating: As required for photovoltaic power system voltage.

2.06 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.

2.07 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 260519

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.

G. Ground enhancement material.

H. Ground access wells.

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 260536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 263100 - Photovoltaic Collectors: Additional grounding and bonding requirements for photovoltaic systems.

E. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2022.

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 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 System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
   3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

E. 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 three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 10 feet from each other and any other ground electrode.
   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
   d. Provide ground enhancement material around electrode where indicated.
   e. Provide ground access well for each electrode.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
   c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

F. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame.

H. 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.

I. Cable Tray Systems: Also comply with Section 260536.

J. Photovoltaic Systems: Also comply with Section 263100.

K. 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).
2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gauge of specified conductors.

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.
   4. Manufacturers:
      a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
      b. Erico International Corporation: www.erico.com/#sle.
      c. Galvan Industries, Inc: www.galvanelectrical.com/#sle.
      d. Harger Lightning & Grounding: www.harger.com/#sle.
      e. Substitutions: See Section 016000 - Product Requirements.

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.

G. Ground Enhancement Material:
   1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
   2. Manufacturers:
      a. Erico International Corporation: www.erico.com/#sle.
      b. Harger Lightning & Grounding: www.harger.com/#sle.
      c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.

H. Ground Access Wells:

1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. 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.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
   2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

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 260526

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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; 2024.

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. 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. 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 260529

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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 033000 - CAST-IN-PLACE CONCRETE: Concrete encasement of conduits.

B. Section 078400 - Firestopping.

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 262100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

H. Section 271000 - Structured Cabling: Additional requirements for communications systems conduits.

I. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

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); 2017.

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 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 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, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.

2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated 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.
6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.

D. Embedded Within Concrete:
1. Within Slab on Grade: Not permitted.
2. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit or rigid PVC conduit.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit.

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:

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. Electrical Service Conduits: Also comply with Section 262100.

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. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.
   2. JM Eagle: www.jmeagle.com/#sle.
   3. 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 top of parapet walls.
      c. 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. Underground Installation:
   1. Provide trenching and backfilling in accordance with Section 312316.13.

K. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
   1. Secure conduits to prevent floating or movement during pouring of concrete.

L. 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.

M. 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.
   3. Where conduits are subject to earth movement by settlement or frost.

N. 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.

O. 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.

P. Provide grounding and bonding in accordance with Section 260526.

Q. 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 260533.13

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; 2015.

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.

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 260533.16

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Warning signs and labels.

1.02 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

B. Section 260536 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.

C. Section 260573 - Power System Studies: Arc flash hazard warning labels.

D. Section 262726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

E. Section 263100 - Photovoltaic Collectors: Additional identification requirements for photovoltaic systems.

F. 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) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
         5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
      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. Arc Flash Hazard Warning Labels: Comply with Section 260573.
   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.

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.

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.

D. Identification for Cable Tray: Comply with Section 260536.

E. Identification for Boxes:
1. Use identification labels to identify circuits enclosed.

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.

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 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. Secure rigid signs using stainless steel screws.

G. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - 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 260553

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SECTION 260573
POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Short-circuit study.

B. Protective device coordination study.

C. Arc flash and shock risk assessment.
   1. Includes arc flash hazard warning labels.

D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 RELATED REQUIREMENTS

A. Section 260553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

B. Section 262100 - Low-Voltage Electrical Service Entrance.
   1. Includes Utility Company contact information.

C. Section 262413 - Switchboards.

D. Section 262416 - Panelboards.

E. Section 262813 - Fuses.

F. Section 262816.16 - Enclosed Switches.

1.03 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2023.

B. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).

C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).

D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.

F. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations; 2018, with Errata (2019).

G. NEMA MG 00001 - Motors and Generators; 2024.

H. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   2. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Pre-Study Meeting: Conduct meeting with Owner to discuss system operating modes and conditions to be considered in studies.

C. Sequencing:
   1. Submit study reports prior to or concurrent with product submittals.
   2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
   3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

1.05 SUBMITTALS

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

B. Study preparer's qualifications.

C. Field testing agency's qualifications.

D. Study reports, stamped or sealed and signed by study preparer.

E. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
   1. Include characteristic time-current trip curves for protective devices.
   2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   3. Include documentation of listed series ratings upon request.
   4. Identify modifications made in accordance with studies that:
      a. Can be made at no additional cost to Owner.
      b. As submitted will involve a change to the contract sum.

F. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

G. Site-specific arc flash hazard warning labels.

H. Field quality control reports.

I. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

J. Project Record Documents: Revise studies as required to reflect as-built conditions.
   1. Include hard copies with operation and maintenance data submittals.
   2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.06 POWER SYSTEM STUDIES

A. Scope of Studies:
   1. Perform analysis of new electrical distribution system as indicated on drawings.
   2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
   3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
      a. Known Operating Modes:
         1) Utility as source.

B. General Study Requirements:
   1. Comply with NFPA 70.
   2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
         1) Obtain up-to-date information from Utility Company.
         2) Utility Company: See Section 262100 for Utility Company contact information.
      b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
      c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 00001 code letter designation.
      d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
      e. Protective Devices:
         1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
         2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
      f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
      g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:
   1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
   2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
      a. Maximum utility fault currents.
      b. Maximum motor contribution.
      c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
   3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
   1. Comply with applicable portions of IEEE 242 and IEEE 399.
   2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
   3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Arc Flash and Shock Risk Assessment:
   1. Comply with NFPA 70E.
   2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
   3. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.

4. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
   a. Maximum and minimum utility fault currents.
   b. Maximum and minimum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:
   1. General Requirements:
      a. Identify date of study and study preparer.
      b. Identify study methodology and software product(s) used.
      c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
      d. Identify base used for per unit values.
      e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
      f. Include conclusions and recommendations.
   2. Short-Circuit Study:
      a. For each scenario, identify at each bus location:
         1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
         2) Fault point X/R ratio.
         3) Associated equipment short circuit current ratings.
      b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
   3. Protective Device Coordination Study:
      a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
      b. For each graph include (where applicable):
         1) Partial single-line diagram identifying the portion of the system illustrated.
         2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
         3) Conductors: Damage curves.
         4) Transformers: Inrush points and damage curves.
         5) Motors: Full load current, starting curves, and damage curves.
         6) Capacitors: Full load current and damage curves.
      c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
         1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
         2) Include ground fault pickup and delay.
         3) Include fuse ratings.
         4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
      d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
   4. Arc Flash and Shock Risk Assessment:
      a. For the worst case for each scenario, identify at each bus location:
         1) Calculated incident energy and associated working distance.
         2) Calculated arc flash boundary.
         3) Bolted fault current.

4) Arcing fault current.
5) Clearing time.
6) Arc gap distance.

b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

c. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq cm.

1.07 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in the preparation of studies of similar type and complexity using specified computer software.
1. Study preparer may be employed by the manufacturer of the electrical distribution equipment.
2. Study preparer may be employed by field testing agency.

B. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.
1. Field Supervisor: Certified electrical testing technician; NETA ETT Level III.

C. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
1. Acceptable Software Products:
a. EasyPower LLC: www.easypower.com/#sle.
b. ETAP/Operation Technology, Inc: www.etap.com/#sle.
c. Power Analytics Corporation: www.poweranalytics.com/#sle.
d. SKM Systems Analysis, Inc: www.skm.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.

PART 2 PRODUCTS

2.01 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
1. Materials: Comply with Section 260553.
2. Minimum Size: 4 by 6 inches.
3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
a. Include orange header that reads "WARNING" unless otherwise indicated.
b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
c. Include the following information:
1) Arc flash boundary.
2) Available incident energy and corresponding working distance.
3) Site-specific PPE (personnel protective equipment) requirements.
4) Nominal system voltage.
5) Limited approach boundary.
6) Restricted approach boundary.
7) Equipment identification.
8) Date calculations were performed.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install arc flash warning labels in accordance with Section 260553.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements, for additional requirements.

B. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Adjust equipment and protective devices for compliance with studies and recommended settings.

E. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.

F. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.03 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Training: Include as part of the base bid training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.
   1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.
   2. Provide minimum of eight hours of training.
   3. Instructor: Representative of entity performing study.
   4. Location: At project site.

END OF SECTION 260573

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 260583

SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Occupancy and Daylighting Sensor Control
   2. 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 comliant 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. 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. 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 QuicKit. 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 QuicKit 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. Low voltage device:24vdc
   9. 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. 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 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

2.10 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.

2.11 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 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 completey 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 ocntrol devices.

F. Verify that the srevice 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. Oreint 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 rought opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or omproperly 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 coverate 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 floor and as per manufacturer's recommendations, in order to minimize false triggers.

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.

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 260923

SECTION 260961

PRODUCTION LIGHTING CONTROL 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 SCOPE

A. All materials, components, and services necessary to provide a complete system indicated in this Section, as specified herein and shown on related Drawings, including:
   1. Verification of dimensions and conditions at the job site.
   2. Preparation and submission of complete shop drawings and samples for approval prior to fabrication.
   3. Shipment of equipment to the job site and the secured storage of all non-fixed equipment.
   4. Installation and completion in accordance with these Specifications, related Drawings, the Production Lighting Equipment Manufacturer's recommendations, established trade criteria, and all applicable code requirements.
   5. The inspection, demonstration, and necessary adjustment of the completed installation by the Production Lighting Equipment Manufacturer's engineering personnel.
   6. Preparation and submission of complete record drawings and operational and maintenance data and certificates.

1.03 WORK INCLUDED

A. The following is for reference only and is not intended to define the limits of the work for a complete installation:
   1. DMX-controlled relay panels.
   2. Control racks and devices.
   3. Network data system.
   4. Control receptacle panels.
   5. House light control panels.
   6. Entry stations.
   7. Company switches.
   8. Wiring devices.
   9. Production lighting fixtures and accessories.
   10. Production lighting control console and accessories.
   11. Box boom or tormentor lighting assemblies.

B. The following work shall be completed by the Contractor but not by the Production Lighting Equipment Manufacturer or Production Lighting Equipment Contractor. The following is for reference only and is not intended to define the limits of work for the Contractor:
   1. Electrical feeds, conduit, wire, control cable, and connections except as indicated herein.
   2. Testing and certification of network cable and terminations.

C. The above is for reference only and is not intended to define the limits of the work for a complete installation.

1.04 RELATED WORK IN OTHER SECTIONS

A. Division 26 installation requirements.
B. Section 11 61 33 – Production Rigging, Curtains and Tracks
C. Section 27 41 00 – Performance Audio / Video System

1.05 QUALIFICATIONS

A. The Production Lighting dimming and control system equipment shall be the responsibility of a single Production Lighting Equipment Manufacturer or Production Lighting Equipment

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Contractor.

B. The Production Lighting Equipment Manufacturer shall have at least ten (10) years' experience in the fabrication of similar equipment and systems. If requested, the Manufacturer shall submit a representative list of installations during the above period.

C. Subject to the above requirements, the equipment specified herein shall be provided by one of the following Production Lighting Equipment Manufacturers:
   1. Control console:
      a. Electronic Theatre Controls (ETC), Middleton, WI.
      b. Approved equal.
   2. Power control and dimmers:
      a. Electronic Theatre Controls (ETC), Middleton, WI.
      b. LynTec, Lenexa, KS.
      c. Vari-Lite, Dallas, TX.
      d. Approved equal.
   3. Emergency lighting devices:
      a. Electronic Theatre Controls (ETC), Middleton, WI.
      b. Lex Products, Stamford, CT.
      c. Vari-Lite, Dallas, TX.
      d. Approved equal.
   4. Lighting Control Data Networking:
      a. As noted herein.
   5. Wiring devices:
      a. Altman Stage Lighting, Denver, CO.
      b. Electronic Theatre Controls (ETC), Middleton, WI.
      c. Lex Products, Stamford, CT.
      d. Performance Electric, Inc., Greenville, SC.
      e. Southeast Stage Rigging & Curtains (SSRC), Greenville, SC.
      f. Stagecraft Industries, Portland, OR.
      g. Union Connector, Roosevelt, NY.
      h. Approved equal.
   6. Additional equipment and devices not identified above shall be provided as per the articles below.

D. Other Production Lighting Equipment Manufacturers may be considered with the prior review and approval of Schuler Shook. Manufacturers seeking approval to bid must contact Schuler Shook and provide the following information not less than ten (10) days prior to the bid date:
   1. List of projects of similar scale and complexity completed in the last five (5) years. Provide project name, location, completion date, and description of equipment installed.
   2. Samples of shop drawing submittals for projects of similar scale and complexity completed in the last five (5) years.
   3. Technical data sheets for any product proposed for use on this project.
   4. Samples of any products requested by Schuler Shook.

E. The Production Lighting dimming and control system shall be provided by a qualified Production Lighting Equipment Contractor who shall have at least five (5) years' experience in the sales and installation of similar systems and who shall be factory certified to provide warranty service for all of the equipment in this Section. Contractor shall meet the requirements for Full Membership in the Entertainment Services and Technology Association (ESTA).

F. The Contractor shall be responsible for the integration, operation, and performance of all elements of the system described in this Section. The Contractor shall provide all warranty

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work and equipment upgrades as called for in this Section.

G. The Contractor or Manufacturer shall be available for onsite product service within (24) hours of a call for service.

H. Subject to the above requirements, the equipment specified herein shall be provided by one of the following Production Lighting Equipment Contractors:
   1. 4Wall Lighting, Moonachie, NJ; (201) 329-9878.
   2. Barbizon Lighting, New York, NY; (212) 586-1620.
   3. Hayden Productions, East Brunswick, NJ; 732-967-0080.

I. Other Production Lighting Equipment Contractors may be considered with the prior review and approval of Schuler Shook. Contractors seeking approval to bid must contact Schuler Shook and provide the following information not less than ten (10) days prior to the bid date:
   1. List of projects of similar scale and complexity completed in the last five (5) years. Provide project name, location, completion date, and description of equipment installed or services provided. Provide contact name, title and phone number for references familiar with Contractor's work on each project listed.
   2. Samples of shop drawing submittals for projects of similar scale and complexity completed in the last five (5) years. Sample drawings shall be provided in PDF format only.
   3. Name, resume and number of years of employment for Contractor's Project Manager assigned to this project.

1.06 SUBMITTALS

A. With Bid:
   1. Contractor shall submit a complete bill of materials to be furnished.
   2. A list of any and all proposed deviations or exceptions from the contract Drawings and Specifications, whether or not these variations have been formally or informally accepted by Schuler Shook. Any deviations or exceptions from the Drawings or Specifications proposed after bid shall not be accepted.
   3. Manufacturer shall indicate any additional wire or conduit runs that are not shown on the Drawings that will be required to install Manufacturer's system.
   4. A schedule for the anticipated completion of the following:
      a. Shop drawings.
      b. Delivery of all equipment.
      c. Commissioning of all systems.

B. Shop Drawings:
   1. Within sixty (60) days of receipt of order, the Manufacturer shall submit one (1) complete set of computer-generated drawings in PDF format to the Architect, Electrical Engineer, and Schuler Shook for approval prior to fabrication:
      a. Dimensions, components, and finishes of all equipment and accessories.
      b. All system assemblies and major sub-assemblies, cabinets, and enclosures, including notation of type and manufacture of switches, relays, locks, hardware, and electrical and electronic connectors.
      c. Quantities of each component and sub-assembly.
      d. Block schematics of system internal wiring and system element interconnection.
      e. Indication by boxed caption of any and all deviations or exceptions from the contract Drawings and Specifications, whether or not those variations have been formally or informally accepted by Schuler Shook.
      f. Indication by boxed caption of any and all additional wire or conduit runs that are not shown on the Drawings that will be required to install Manufacturer's system.

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C. Samples:
   1. Within sixty (60) days of receipt of order, the Manufacturer shall, if requested, submit to Schuler Shook for approval prior to fabrication:
      a. Samples of any equipment component requested by Schuler Shook.
   2. Samples shall not be considered part of specified quantities but shall be returned to Manufacturer upon request.

D. Final Submittal:
   1. Within thirty (30) days of final tests, and as a condition for final approval, the Contractor shall submit:
      a. Receipts for delivery of all non-installed items, including all items designated, “deliver to Owner.” Delivery receipts shall include name and quantity of each piece of equipment specified, with confirmation signature by Contractor or Owner’s representative.
      b. “As built and approved” CAD drawings and wiring diagrams showing all systems and components as installed, including all field modifications.
      c. Operation and service manuals, schematics, and parts lists for each unit of equipment installed or provided. A printed, bound manual is required for each control console.
      d. Digital copies of video-recorded instructions as described below.
      e. Certificates of warranty, as set forth below.
   2. Provide copies of all Final Submittal documents and drawings as follows:
      a. Two (2) printed and bound sets to the Owner.
      b. One (1) digital copy to the Owner.
      c. One (1) digital copy to Schuler Shook.

1.07 TESTING AND INSTRUCTION

A. Upon completion of all installation work, the Contractor shall certify in writing to the Architect that the work is complete and ready for final inspection. Final inspection shall be scheduled by the Owner, Architect, and Schuler Shook within fourteen (14) days following Contractor’s notice of completion.

B. After system commissioning and adjustment, a knowledgeable representative of the Manufacturer shall operate the system for the approval of the Owner and Schuler Shook.

C. Necessary adjustments or modifications shall be made as required.

D. Manufacturer’s representative shall instruct the Owner’s designated staff or representatives in the operation and maintenance of all equipment as follows:
   1. The first instruction session shall encompass a complete and detailed orientation to the system, including all controllers, control accessories, power and data distribution, receptacle panels, and production lighting fixtures. This instruction session shall be scheduled to last a minimum of six (6) hours where a minimum of four (4) hours is dedicated to the lighting control console(s).
   2. The second instruction session shall include a review of first session topics as requested by the Owner’s staff, as well as advanced control console programming. The second session shall occur within sixty (60) days of the first session, or during the first public performance at the Owner’s request. This instruction session shall be scheduled to last a minimum of four (4) hours.

E. The Manufacturer shall provide to the Owner video-recorded instructions on the operation and maintenance of the system. Information contained in the video will cover all points of operation and maintenance covered in the first instruction session with the Owner’s staff. A recording of the actual instruction session is acceptable. Provide digital media containing full copies of the video instruction.

1.08 INSURANCE AND WARRANTY

A. All equipment shall be fully insured against loss or damage during shipment, job site storage, installation, and testing. The Contractor shall have and assume full responsibility

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for the safety of every unit of equipment, components, wiring, and plans during delivery, installation, and testing. Certification of such coverage shall be furnished to the Architect within thirty (30) days of award of contract.

B. For a period of one (1) year following final acceptance, the Production Lighting Equipment Manufacturer shall unconditionally warrant all other equipment and systems provided under this Section to be free from defects in materials and workmanship. Lamps and normal wear and tear are exempted.

C. For a period of two (2) years following final acceptance, the Production Lighting Equipment Contractor shall provide and install, at no cost to the Owner, software or firmware upgrades to all components of all control systems including consoles and architectural lighting controllers.
    a. The Contractor shall notify the Owner of all software upgrades for the life of the control system(s).
    b. The Contractor shall keep the Owner's name and address in a database for this purpose. All upgrades shall include a full written description of operational modifications.
    c. Software upgrades shall be designed so as to allow all existing data, configurations and show files to be maintained, accessed and edited in the future.

D. Appropriate additional equipment to replace equipment removed for service shall be provided at the job site at no expense to the Owner. Replacement control console(s) must be of the same model as those removed for service.

E. Warranty service shall be performed by personnel in the employ of the Production Lighting Equipment Manufacturer and shall not be sub-contracted or assigned to another company, service, or individual unless the Owner has approved such assignment in writing, in which event the Production Lighting Equipment Manufacturer shall nevertheless be responsible to the Owner for such work.

1.09 GENERAL REQUIREMENTS

A. General Conditions of the project contract, work schedules, and site regulations apply to this work.

B. This work shall comply with all applicable national and local labor regulations.

C. All electrical work and products shall conform to all applicable NFPA 70 National Electric Code (NEC) standards. It is the Contractors' responsibility to verify and comply with all national and local codes.

D. All control signal terminations shall be made by the Production Lighting Equipment Manufacturers' installation technician.

PART 2 - PRODUCTS

2.01 GENERAL

A. All components shall be new, of first quality, and under warranty.

B. All components shall be UL listed and carry pertinent UL labels.

C. All components shall bear labels identifying the manufacturer, model number, and serial number. All such labels and certificates shall be permanently attached in a conspicuous location.

D. Identification:
    1. All control and receptacle faceplates shall be identified and legended with permanent markings.
    2. All control and receptacle faceplates not described elsewhere in this Specification shall be black anodized aluminum or black painted steel, and all labels and legends shall be permanently engraved directly into the faceplate.
        a. Minimum text height if not specified elsewhere: 1/4 inch.
        b. Engravings shall be filled with white paint.
        c. Lamacoid labels shall be acceptable if mechanically fastened to the panel.

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3. Dry transfers, decals, plastic “dymo”, or other types of adhesive labels shall not be used. Silk-screened labels or legends shall not be used.
4. All control and receptacle faceplates shall have beveled edges and rounded corners.

E. Control signal protocol and connectors shall comply with applicable standards established and published by the U.S. Institute for Theatre Technology. The control signal protocol shall be equal to ANSI E1.11-2024 DMX512-A.

F. All multi-conductor connectors shall be wired in accordance with the recommended practice RP-1 as published by the U.S. Institute for Theatre Technology.

G. All control, signal, and video connectors shall be of substantial construction and shall be of the locking or latching type. All plate-mounted connectors shall be bolted to faceplates, rivets shall not be acceptable.

H. All components requiring external electrical connections of more than seven (7) conductors shall include barrier-type terminal strips properly sized and permanently labeled.

I. Where specification allows for “approved equal,” substitutions shall be proposed to Schuler Shook no less than ten (10) days prior to bid date.

2.02 DMX-CONTROLLED BREAKER / RELAY PANEL – MAINS FEED

A. The system described below is based upon general performance criteria common to the products listed below. No other system shall be considered unless specifically approved by Schuler Shook at least ten (10) days prior to the bid date:
1. Electronic Theatre Controls “Echo Relay Panel – Mains Feed”
2. Vari-Lite “RigSwitch+ Mains-Fed.”
3. Approved equal by Lex Products or Lyntec.

B. Physical Requirements:
1. The panel(s) shall be deadfront, substantially framed, and enclosed with sheet metal panels. Access for installation and maintenance shall be provided through the front . All parts shall be properly cleaned prior to painting and then painted with a rust inhibiting primer. The finish paint shall be baked enamel.
2. Panel shall not exceed 15” wide by 6’-0” high by 4 inches deep. Knockouts shall be provided both on top and bottom of panel for external connections.
3. Relays shall be individually replaceable for ease of maintenance.

C. Electrical requirements.
1. Panel shall be designed to operate at a voltage of 120/208 volts, 60 hz, 3-phase 4-wire, with the main busses of each rack sized for maximum full loading of all contained breakers/relays.
2. Panel shall include Main Breaker, usually 120V three-phase, 100A. Confirm all panel feed sizes and provide the appropriate main breaker.
3. Panel shall include twenty nine (29) 20A, single-pole breakers unless indicated otherwise on the Drawings or Schedules. Twenty four (24) breakers shall feed relays, the remaining five (5) breakers shall be available for auxiliary loads.
4. Provide 300 watt dimmers, GFCI breakers, multi-pole breakers and multi-pole relays as indicated on the Drawings or Schedules.
5. Panel shall be UL listed with separate chambers for Class 1 and Class 2 wiring.
6. Panel shall include barriers to separate circuits of different voltages or to separate emergency circuits from non-emergency circuits. Verify all requirements.
7. Panel(s) shall be completely wired internally, and terminals of the proper rating shall be provided for all external connections. Each terminal shall be clearly and permanently marked and numbered.
8. Panel shall utilize individual single pole, latching breakers/relays rated for a minimum of 60,000 cycles at full load.
9. Breakers/Relays shall be designed to operate at a line voltage of 120 volts, 60 hz.
10. Relays shall be appropriate for general purpose use and HID, magnetic or electronic ballasts. Verify all connected fixture types and loads.

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11. Panel shall include UL 924-listed emergency contact input. Selected relays shall be powered at “full” during the loss of normal power.
12. Selected panel(s) will be fed normal and emergency power as indicated on the drawings. When emergency power is provided to the racks, all programmed circuits shall be turned on.

D. Electronic requirements.
1. Panel shall use a dedicated multiplexed signal conforming to the ANSI E1.11-2004 DMX512-A standard. Each relay in the panel shall be controlled by an individual DMX address. DMX termination shall be provided as required.
2. An interruption of the DMX signal shall cause the panel to “hold last look” and maintain all relays in their current position until DMX is restored.
3. Breakers/Relays may be individually selected for manual override control at the panel.

E. Control Requirements.
1. Provide the following control output and feature cards, as required for architectural lighting fixtures connected to panels:
a. Option card with 0-10V control signal output.
b. Option card with lighting system network connectivity.
c. Option card with ride-thru for electrical fluctuations.

F. Provide panels containing individual DMX-controlled breakers / relays as indicated in the Schedule of Quantities.

G. Install as indicated on the Drawings.

2.03 DMX-CONTROLLED MOTORIZED BREAKER PANEL – MAINS FEED

A. The system described below is based upon general performance criteria common to the products listed below. No other system shall be considered unless specifically approved by Schuler Shook at least ten (10) days prior to the bid date:
1. Electronic Theatre Controls “Sensor IQ Intelligent Breaker Panel.”
2. Approved equal by Lex Products or Lyntec.

B. Physical Requirements:
1. The panel(s) shall be deadfront, substantially framed, and enclosed with sheet metal panels. Access for installation and maintenance shall be provided through the front. Knockouts shall be provided both on top and bottom of panel for external connections.
2. All parts shall be properly cleaned prior to painting and then painted with a rust-inhibiting primer. The finish shall be powder coat or epoxy paint.
3. Panel for up to 24 circuits shall not exceed 15-inches wide x 51-inches tall x 5-inches deep.
4. Panel for up to 48 circuits shall not exceed 20-inches wide x 64-inches tall x 6-inches deep.
5. Breakers shall be individually replaceable for ease of maintenance.

C. Electrical requirements.
1. Panel shall utilize 3-phase 120/208V four-wire plus ground mains feed.
2. Breakers shall be single, two or three poles and rated for up to 30A.
3. Panel shall be UL listed with separate chambers for Class 1 and Class 2 wiring.
4. Panel shall include barriers to separate circuits of different voltages or to separate emergency circuits from non-emergency circuits. Verify all requirements.
5. Panel shall include UL 924-listed emergency contact input. Selected circuits shall be powered at “full” during the loss of normal power.

D. Electronic requirements.
1. Panel shall use a dedicated multiplexed signal conforming to the ANSI E1.11-2004 DMX512-A standard. Each breaker in the panel shall be controlled by an individual DMX address. DMX termination shall be provided as required.

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2. An interruption of the DMX signal shall cause the panel to “hold last look” and maintain all breakers in their current position until DMX is restored.

E. Control Requirements.
1. Provide the following control output and feature cards, as required for architectural lighting fixtures connected to panels:
a. Option card with 0-10V control signal output.
b. Option card with lighting system network connectivity.
c. Option card with ride-thru for electrical fluctuations.

F. Provide panels containing individual DMX-controlled motorized breakers as indicated in the Schedule of Quantities.

G. Install as indicated on the Drawings.

2.04 LIGHTING CONTROL INTERFACE RACK

A. Control Interface Rack(s) shall be 19-inch industry standard equipment rack. Design and configuration of the control interface rack(s) shall contain equipment as listed below and any other devices necessary for a complete system.

B. Physical Requirements:
1. Equipment rack(s) shall be fully welded construction using minimum 16 gauge steel and finished in black powder coat.
2. Equipment rack(s) shall be wall-mounted at location(s) shown on the Drawings.
3. Equipment rack(s) shall include a front access door with integral lock. Door may be inverted on site for opposite swing. Provide six (6) keys to Owner. Label door: “Production Lighting Control Interface”
4. The depth of the Equipment rack(s), including front access door, shall not exceed 27 inches.
5. The height of the Equipment rack(s), including front access door, shall be sized to accommodate all required components, specified below, and shall not exceed 68.25 inches.

C. Equipment rack(s) shall contain the following components:
1. Architectural lighting processor(s).
2. Network switch(s) and patch bay(s).
3. Centralized DMX Distribution device(s).
4. Power conditioner or surge protection, per specification.
5. Cable management.
6. Minimum 2U blank rack space for future use.
7. Blank panels as required.
8. Additional devices, as required, for a complete and operable system.

D. Provide DMX output(s) to LED architectural lighting fixtures in the auditorium. Coordinate DMX control with fixture manufacturer and Contractor for a complete and operable system.

E. Provide 0-10 volt controller(s) for LED architectural lighting fixtures requiring 0-10 volt control. Coordinate control wiring with fixture manufacturer and Contractor for a complete and operable system.

F. All devices installed at the Control Interface Rack shall operate silently if installed within the auditorium, stagehouse or control room. Fan noise, transformer hum, or other acoustic interference shall not be acceptable.

G. Installation shall include appropriate cable management, terminal blocks and labels.

H. All devices, stations, and blank panels contained within rack(s) shall be “black.”

I. Manufacturer: Middle Atlantic Products or approved equal.

J. Install as indicated on the Drawings.

2.05 POWER CONDITIONER WITH BATTERY BACKUP

A. Rack-mounted Power Conditioners with battery back-up shall be provided to protect all lighting control devices from electrical irregularities such as surges, “spikes” and emergency transfer. Battery back-up shall be sized to maintain power to all connected

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devices for a minimum of fifteen (15) minutes.

B. Provide one (1) Power Conditioner with battery back-up for each of the following equipment rack locations:
   1. Control interface rack(s) and for all external network devices requiring a power source.

C. All devices installed at the Stage Manager's Rack shall operate silently. Fan noise, transformer hum, or other acoustic interference shall not be acceptable.

D. Manufacturers:
   1. Furman Sound "F1500-UPS."
   2. American Power Conversion (APC).
   3. Best Power Technology, Inc.
   4. Approved equal.

E. Install as indicated on the Drawings.

2.06 NETWORK DATA SYSTEM

A. The Network Data System shall provide for the interconnection of devices used solely for production lighting and special effects.

B. A dedicated network is required for the lighting control system. The network shall consist of receptacle panels, connecting wiring, patch bays, patch cables, routers, switches, and portable node devices.

C. All materials, components, and services necessary to provide a complete network data system indicated in this Section. Manufacturer shall be responsible for performance of the complete system.

D. All lighting control devices shall operate as part of the network. If the manufacturer's system requires devices that are not network compatible, manufacturer shall provide all required hardware to accommodate those devices to meet the intent of this specification. Division 26 shall provide and install conduits, boxes, and conductors to accommodate these devices, as part of the work of this Section.

E. The network shall provide for the connection of the following devices:
   1. Control consoles.
      a. DMX outputs.
      b. Dimmer feedback information.
   2. Remote video displays.
   3. Designer's remote control consoles.
   4. Hand-held remote controls.
      a. Dedicated lines to console locations if required.
   5. Automated lighting fixtures.
   6. Moving yoke devices.
   7. Color changers.
   8. LED lighting fixtures.
   9. DMX-controlled special effects.
   10. Architectural lighting control system.

F. Network capacity shall be determined by the following simultaneous usage criteria. System shall allow all the data below to be sent simultaneously, within the traffic and collision maximums noted below:
   1. Control consoles – quantity one (1).
   2. Remote video displays – quantity two (2) in use, in two separate locations.
   3. Designer's remote control consoles – quantity one (1).
   4. Hand-held remote controls – quantity one (1).
   5. Distributed DMX signal – eight (8) 512-dimmer universes for automated lighting, color changers and special effects. System shall be designed for the quantity of DMX nodes specified herein and a 50% future expansion of DMX node devices.
   6. Architectural lighting control system – as specified herein.

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G. All permanently-installed lighting network or data cable shall be in conduit. All cables shall be terminated at the Control Interface Rack(s) and at the Control Receptacle Panel(s) with no breaks or splices between devices.

H. The system shall utilize Category 5e cable for all lighting network and all DMX wiring. UTP wiring shall be 4 pair, 24 AWG, unshielded twisted pair wiring. All network connectors shall be RJ45.

I. Fiber optic wiring is permissible for "backbone" wiring runs. Fiber optic wiring shall be 62.5/125/900 Micron Fiber Optic wiring. All fiber optic connectors shall be ST style connectors.

J. All elements of the system shall meet the following requirements:
   1. Institute of Electrical & Electronic Engineers Standard 802.3: 1996 (E), ANSI/IEEE Standard 802.3, 1993 Edition.
   2. Electronic Industries Association/Telecommunications Industries Association Standard 568-1995.
   3. TIA/EIA Bulletin TSB67 for field testing of unshielded twisted-pair cabling systems.
   4. ESTA CP/96-1057r1 Recommended Practice for Ethernet Cabling Systems in Entertainment Lighting Applications and CP/98-1005r3, Supplement to the Recommended Practice.

K. All system elements shall be provided from a qualified network hardware manufacturer. The manufacturer shall have at least five (5) years' experience in the fabrication of network hardware. Subject to the above requirements, the equipment indicated herein shall be by one of the following manufacturers:
   1. 3Com Corporation.
   2. Allied Telesis.
   3. Cisco Systems.
   4. Hubbell Premise.
   5. Netgear.
   6. Panduit.
   7. Approved equal.

L. Network Switches:
   1. The System shall utilize Network Switches for data distribution. The Switches shall be rack-mounted in the Control Interface Rack(s) and completely wired internally.
   2. The Switches shall include sufficient ports for patching all network devices, plus six (6) spare receptacles per Control Interface Rack.
   3. The Switches shall accommodate 100Mbs transmission rate.
   4. All Switch ports shall be labeled with designation of wire destination.

M. Network Patch Panels:
   1. The System shall utilize central Patch Panels for patching individual network devices to the Switches. The Panels shall be rack-mounted in the Control Interface Rack(s) and completely wired internally.
   2. The Panels shall include sufficient network receptacles for patching all network devices, plus six (6) spare receptacles per Control Interface Rack.
   3. The Panels shall allow for distribution of the network wiring. If multiple collision domains exist in the same patch panel, they must use patch cables of different colors to delineate the separate collision domains.
   4. The Rack shall include wire management panels as manufactured by Panduit or approved equal.
   5. All wires shall be identified at the jacket with separate numbers.
   6. All network receptacles shall be labeled with designation of wire destination.

N. Network Cables and Patch Cables:
   1. Cables shall be rated Category 5e to match installed wiring.
   2. Cables shall include RJ45 plugs at each end, for proper mating to receptacle panels

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and node devices. Each cable shall be protected by a rubber boot of a diameter sufficient to extend beyond the plug connection tab.

3. Patch cables and boots shall use multiple colors to differentiate collision domains. Drop cables and boots 10'-0" long or more shall be black.
4. Provide one (1) patch cable of appropriate length for patching each switch port to the designated network receptacle. Provide one (1) spare patch cable for each spare switch port.
5. Deliver to Owner.

O. Wiring Methods:

1. All permanent network wiring shall terminate in receptacles in panels. All equipment shall be connected to receptacles via "patch cables" with RJ45 plugs. No installed wire shall terminate directly to network equipment. The use of male RJ45 pigtails shall not be permitted.
2. Cable shall be pulled in conduits, meeting the minimum bending radius permitted by the cable manufacturer. All cable shall be pulled with no more than the maximum pulling tension permitted by the cable manufacturer.
3. Riser rated or plenum rated cable shall be used where required under local codes.

P. Electrical Requirements:

1. All UTP wiring segments shall be of continuous runs of not more than 250 feet. If a wiring run exceeds the noted maximum footage, manufacturer shall provide required repeaters and system elements to bring the wiring segment to the stated maximum run. Contractor shall provide and install such elements as part of the work of this Section.
2. All cable shall meet the standards for EIA/TIA 568 TSB-36 Category 5e. The Contractor shall use a current generation 100Mhz or higher, network/cable analyzer to perform testing on the cable plan and shall test all data pairs. All cable shall be tested for continuity, attenuation, near end crosstalk, mutual capacitance, cable impedance, cable resistance, cable length, structural return loss and pair mapping. All testing will be performed by certified cable technicians. As part of the final submittal, provide cable analyzer printouts of all test performed, labeled by cable number.
3. All wiring shall meet the EIA/TIA T586B wiring standard.
4. All cable and installation shall accommodate 100Mbs transmission rate. "Thin Net" systems shall not be used.
5. The system shall be designed for maximum 40% traffic utilization and maximum 10% collisions within the same collision domain. The use of switches is acceptable to manage network traffic.
6. All Layer 2 switches shall provide for IGMP Layer 3 snooping to accommodate IP multicast events.

2.07 CENTRALIZED DMX DISTRIBUTION

A. The system described below is based upon general performance criteria common to the products listed below. No other system shall be considered unless specifically approved by Schuler Shook at least ten (10) days prior to the bid date:

1. Electronic Theatre Controls "Net3 Four Port Gateway."
2. Pathway Connectivity "Pathport Quattro Node."
3. Pathway Connectivity "Pathport Octo Node."
4. Vari-Lite "Gateway."
5. Approved equal.

B. The Centralized DMX Distribution system shall be located at the Control Interface Rack and employ the above noted device(s). The system shall provide for the translation of network control data into discrete DMX512 data streams to the indicated receptacles on the Control Receptacle Panels, per the drawings and schedules. The system shall be designed with

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the following functionality:

1. The device(s) shall be capable of accepting the following lighting control network data: ACN; sACN; RDM; ETC Net3; ShowNet.
2. The device(s) shall use a dedicated multiplexed signal conforming to the ANSI E1.11-2004 DMX512-A standard.
3. DMX512 data streams shall be optically isolated.
4. Each discrete DMX512 data stream shall be programmable to provide data within the specified DMX512 Universe(s).

C. Wiring between Centralized DMX Distribution system devices and indicated receptacles on the Control Receptacle Panels, per the drawings and schedules, shall:
   1. Utilize Category 5E cable for transmission of DMX512 data.
   2. Cable length shall be limited to 250 feet.
   3. Follow all recommended practices, unless otherwise noted above, of ANSI E1.27-2 - 2009 (R2014) – Recommended Practice for Permanently Installed Control Cables for Use with ANSI E1.11 (DMX512-A) and USITT DMX512/1990 Products.

D. All wires shall be identified at the jacket with separate numbers.

E. The device(s) shall provide one discrete input or output for each DMX receptacle in the system plus four (4) spare inputs/outputs. Provide rear-mounted terminals for the connection of all DMX wiring.

F. Multiple DMX receptacles on a single input or output cable shall not be accepted.

G. Install in the Control Interface Rack.

2.08 CONTROL RECEPTACLE PANEL

A. The Control Receptacle Panels shall be deadfront, and completely wired internally, with terminal strips of the proper rating for all external connections. Appropriate back boxes shall be provided for all panels.

B. The face of each panel shall contain flush mounted receptacles for connection to the devices indicated. These receptacles shall be of the locking type and shall be sized for the proper number and capacity of conductors.
   1. DMX connectors shall be equal to XLR series by Switchcraft.
   2. Ethernet connectors shall be RJ45.
   3. Smaller or less substantial connectors shall not be acceptable.

C. Initial programming of DMX Receptacles shall be as follows:
   a. If one (1) DMX INPUT then: DMX INPUT shall be 1-512 and control house dimmers unless noted otherwise.
   b. If two (2) DMX INPUT then: first DMX INPUT shall be 1-512 and control house dimmers unless noted otherwise; second DMX INPUT shall be 513-1024.
   c. If one (1) DMX OUTPUT then: DMX OUTPUT shall be 513-1024.
   d. If two (2) DMX OUTPUT then: first DMX OUTPUT shall be 1-512 and control house dimmers unless noted otherwise; second DMX OUTPUT shall be 513-1024.
   e. If three (3) or more DMX INPUT or OUTPUT then DMX Receptacle shall be initially programmed for the next sequential DMX Universe.

D. All CRP faceplates shall have a factory-applied paint or anodized finish as indicated in the finish schedule on the Drawings.

E. All faceplates shall be engraved at each connector and backfilled with contrasting epoxy paint. Connector labels as indicated on the Drawings.

F. All CRP panels shall be mounted as indicated on the Drawings and in the Schedules. Provide appropriate back boxes for all CRP panels. Verify all mounting conditions.

G. Install as indicated on the Drawings.

2.09 ARCHITECTURAL LIGHTING CONTROL PROCESSORS

A. The system described below is based upon general performance criteria common to the products listed below. No other system shall be considered unless specifically approved by

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Schuler Shook at least ten (10) days prior to the bid date:
1. Electronic Theatre Controls “Unison Paradigm Architectural Control Processor Mk2.”
2. Interactive Technologies “CueServer Processors.”
3. Vari-Lite “Vision.net Control.”
4. Approved equal.

B. Lighting control racks shall be interconnected as noted on the riser diagrams to allow centralized control of remote fixtures or relays. Provide network or fiber optic cabling as required due to distance between racks.

2.10 HOUSE LIGHT PANEL – LCD WITH SNAPSHOT PROGRAMING

A. The system described below is based upon general performance criteria common to the products listed below. No other system shall be considered unless specifically approved by Schuler Shook at least ten (10) days prior to the bid date:
1. Electronic Theatre Controls “Unison Paradigm Touchscreen.”
2. Interactive Technologies “Insite Touchscreen.”
3. Vari-Lite “Vision.net Touchscreen Station.”
4. Approved equal.

B. Physical Requirements:
1. The Lighting Control Panel shall be deadfront and completely wired internally, with terminals of the proper rating for all external wiring.
2. The face of the panel shall have a touch-screen capable of selection, programming and control of the lighting presets.
3. All control wiring shall be low-voltage Class II.

C. General Operational Requirements:
1. Each panel shall have the capability to access a minimum of ninety nine (99) presets, plus OFF.
2. Each panel shall have the capability to access a minimum of (2048) dimmers.
3. The presets shall be programmed by adjusting and recording the levels of the house light control channels. Presets shall be capable of user-defined sequences.
4. All presets shall have an adjustable fade rate control.
5. The system shall include Macro capability of channels, presets, playback and custom conditional statements.
6. The record function shall be capable of being locked by a passcode to prevent unauthorized use.
7. The system set-up shall be protected by a separate passcode.
8. The system shall provide printable reporting information on the status of all presets, macros, processors, and stations.
9. The system shall accept graphical inputs to allow custom LCD screen configuration.

D. Snapshot Operational Requirements:
1. Each panel shall have the capability of accessing DMX addresses 1-2048.
2. The snapshot potentiometers shall be programmed by recording the current “live” status of DMX addresses 1-2048. Snapshot presets may include any stage or house lighting dimmer within this DMX universe.
3. The presets shall have an adjustable fade rate control.
4. The record function shall be capable of being locked to prevent unauthorized use.

E. The system shall provide for storing of all program, preset and system set-up configuration to removable media. Provide three (3) units of media.

F. All House Light Panels shall be mounted as indicated on the Drawings and in the Schedules. Provide appropriate back boxes for all panels. Verify all mounting conditions.

G. HLP-xx shall be portable and include a 25’-0” cable with connector suitable for mating with the control receptacle panels.
1. Portable HLP shall consist of a standard LCD panel, per specification, mounted in a custom enclosure, per the drawings.

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2. Portable HLP shall utilize network ports to connect to the lighting control network and shall operate on PoE and external power supply.

H. Faceplate color and labels shall be as indicated in the Schedules. Manufacturer shall confirm all faceplate colors and labels in shop drawings.

I. All faceplates shall be labeled: “House Lights.”

J. Install as indicated on the Drawings and in the Schedules. House Light Panels are identified as “HLP” throughout the documents.

2.11 ENTRY STATION

A. The system described below is based upon general performance criteria common to the products listed below. No other system shall be considered unless specifically approved by Schuler Shook at least ten (10) days prior to the bid date:
1. Electronic Theatre Controls “Unison Heritage Series Button Station.”
2. Interactive Technologies “CueStation Ultra Button Station.”
3. Vari-Lite “Vision.net Outlook VN Pushbutton Station.”
4. Approved equal.

B. Physical Requirements:
1. The panels shall be deadfront and completely wired internally, with terminals of the proper rating for all external wiring.
2. The face of each panel shall contain momentary contact switches for accessing lighting presets and non-dims as indicated. All buttons shall have integral LED’s, illuminated when activated.
3. All faceplates shall contain an LED indicator lamp for ease of identifying in a darkened room.
4. All control wiring shall be low-voltage Class II.

C. Operational Requirements:
1. Each panel shall contain momentary contact switches for accessing lighting presets as indicated in the Schedules.

D. All Entry Station panels shall be mounted as indicated in the schedule. Provide appropriate back boxes for all panels. Verify all mounting conditions.

E. Faceplate color and labels shall be as indicated in the Schedules. Manufacturer shall confirm all faceplate colors and labels in shop drawings.

F. Provide a clear, lockable cover plate and two (2) keys for each station as indicated in the schedule. Locking cover assembly shall be painted to match station faceplate. Deliver keys to Owner.

G. Entry Station ES-xx shall be a key switch to turn on and off one (1) predetermined lighting preset. Provide six (6) keys to Owner.

H. Install as indicated on the Drawings and in the Schedules. Entry Stations are identified as “ES” throughout the documents.

2.12 WIRING DEVICES

A. General:
1. Wiring Devices shall be constructed of minimum 18-gauge steel. Exterior finish shall be baked enamel, color as indicated in the Schedules.
2. Terminal strips of the proper rating shall be provided for external connections on all components requiring more than seven (7) conductors. Terminal strips shall be clearly labeled and located as indicated on the Drawings.
3. Flush mounted production and / or standard receptacles shall be as specified in this Section.
4. Pigtails shall be production cable as specified in this Section, secured by cushioned strain reliefs, and terminated with production receptacles as specified in this Section.
5. Pigtails exceeding 2’-0” shall have a label applied to the cable with 1/2-inch high black characters on a white field and affixed with clear heat shrink tubing located 6 inches from the connector.

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6. Panel mounted multi-conductor connectors shall be as specified in this Section. All multi-conductor electrical connections shall be soldered and insulated with heat shrink tubing.
7. Circuit numbers shall be engraved lamacoid labels, minimum 1-inch high white letters on a black background. Labels shall be applied with adhesive and mechanically fastened to the wiring device.
8. Units shall be UL listed and carry a UL label.

B. Plug Boxes:
1. Plug boxes shall contain dimmed, relay, and / or non-dim circuits as indicated on the Drawings and in the Schedules.
2. Sizes, quantities and locations as indicated on the Drawings and in the Schedules.
3. Sizes, quantities and locations as indicated on the Drawings and in the Schedules.

C. Plug Strips:
1. Plug strips shall contain dimmed, relay, and / or non-dim circuits as indicated on the Drawings and in the Schedules.
2. Mounting brackets shall be constructed of minimum 3/16-inch x 2 inch steel. Provide sufficient mounting brackets to support plugging strips minimum 5'-0" O.C. plus additional mounting brackets as required for specific conditions.
3. Sizes, quantities and locations as indicated on the Drawings and in the Schedules.

D. Gridiron Junction Boxes:
1. Gridiron junction boxes shall be surface mounted to the roof deck.
2. Access to terminal strips shall be by means of a removable top cover plate. Knockouts shall be provided in all sides for Contractor wiring and for multi-conductor cables.
3. Exterior finish shall be flat black baked enamel.
4. Multi-conductor cables shall be supported at both ends by means of "Kellems" type mesh grips that shall transfer the weight of the cable completely to the external jacket of the cable.
5. Sizes, quantities and locations as indicated on the Drawings and in the Schedules.

E. Multi-Conductor Cables - Plug Strips:
1. Cables shall be multi-conductor cable as specified in this section with two (2) conductors for each circuit required plus a minimum of (2) two ground conductors per cable.
2. The manufacturer shall size the multi-conductor cables as required. There shall be no more than two (2) multi-conductor cables per plug strip.
3. Lengths as indicated on the Drawings and in the Schedules.

F. Cable Cradles:
1. Cradles shall be constructed of cast iron, with grooves and clamps sized to the number and diameter of multi-conductor cables.
2. Provide one (1) cable cradle for each multi-conductor cable plug strip.

G. Cable Clamps:
1. Cable clamps shall secure multi-conductor cables at the pipe batten before they enter the plug strip.
2. Provide one (1) cable clamp for each multi-conductor cable.

H. Floor Boxes:
1. Floor pockets shall be flush floor mounted, with a hinged access cover. Cover plate shall be minimum 3/8-inch thick cast iron, with cast non-skid top surface and at least one cable notch for each receptacle. The back box shall be minimum 20-gauge steel, with knockouts provided in the bottom and on all sides.
2. Receptacles shall be mounted on a minimum 20-gauge steel plate angled for visibility and access.
3. Provide a dust flap for each face plate. Dust flap shall be minimum 1/16-inch sheet

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neoprene, commercial grade, 55/65 Duro. Dust flap shall be sized to completely cover all receptacles, shall be permanently attached to the top of the face plate, and shall be slit once between each receptacle. Dust flap shall be designed and constructed to protect the receptacles from dust when not in use and to be peeled back to allow a cord to be plugged into each receptacle. Paint circuit numbers onto dust flap segments in letters not less than 1 inch high.

4. Sizes, quantities and locations as indicated on the Drawings and in the Schedules.

I. Install as indicated on the Drawings.

2.13 PRODUCTION LIGHTING CABLES

A. Single Circuit Cable:
   1. Single circuit cable for 20-AMP circuits shall be type 12/3 as follows:
      a. SOOW Extra Hard Usage cord for pigtals and portable jumper cables where connector types can accommodate the heavier jacket.
      b. SJOW or SJOOW Junior Hard Service cord for pigtails and portable jumper cables with Neutrik PowerCON or TRUE1 connectors.
      c. SJOW or SJOOW Junior Hard Service cord for all break-outs not over 20 feet (6 meters) in length.
      d. SJTOW Junior Hard Service cord for all two-fers and adapters not over 3.3 feet (1 meter) in length.
   2. Conductors shall be color-coded to identify hot (black), neutral (white) and ground (green).
   3. All cable jackets shall be black unless specifically noted otherwise.

B. Multi-Conductor Cable:
   1. Multi-conductor cables shall be #12 AWG Polyvinyl Chloride (PVC) or Themoplastic Rubber (TPR).
   2. Cable conductors shall be sequentially numbered for identification.
   3. All cable jackets shall be black unless specifically noted otherwise.
   4. Portable multi-conductor cables shall be Lex Products “EverGrip” or TMB “ProMolded” with 5-year warranty.

C. Permanently-installed Ethernet or DMX Cable:
   1. All cables shall contain 4-pair, #23 AWG, shielded Category 5e wiring. Refer to the following standards for DMX signals on 4-pair cable:
      a. ANSI E1.11-2008 Revised 2013 “USITT DMX512-A, Asynchronous Serial Digital Data Transmission Standard….”
      b. ANSI E1.27-2-2009 Revised 2014 “Recommended Practice for Permanently Installed Control Cables for Use with ANSI E1.11.”
      c. ESTA “DMX512 Over Category 5 Cable Summary.”
   2. All permanently-installed lighting network or data cable shall be in conduit. All cables shall be terminated at the Control Interface Rack(s) and at the Control Receptacle Panel(s) with no breaks or splices between devices.
   3. Cable colors:
      a. All permanently-installed lighting network and DMX cable for this project shall have a GREEN jacket to distinguish the lighting network from other network cables.
      b. Confirm cable colors used by AV or IT or other building data systems.
      c. Confirm lighting network cable color in the submittal drawings.
   4. Cable terminations shall follow the ESTA color code and all Production Lighting Manufacturer recommendations.
   5. For cable runs exceeding 1000 feet (300 meters), fiber optic cable is required. Refer to Production Lighting Manufacturer’s standards.

D. Portable Ethernet Cable:
   1. Portable Ethernet cable shall be used for all plug strip data cables and portable

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Ethernet cables that are delivered to the Owner for production use.

2. Cable shall contain 4-pair, #23 AWG, shielded Category 5e wiring. Cable jacket shall be UV resistant polyurethane.
3. All cable jackets shall be black unless specifically noted otherwise.
4. Cables shall be Lex Products “PowerFlex” or TMB “ProPlex” or approved equal.

E. Portable DMX Cable:
1. Portable DMX cable shall be used for all portable DMX cables that are delivered to the Owner for production use.
2. Cable shall contain 2 pair, #22 AWG, shielded twisted pair wiring. Cable jacket shall be UV resistant polyurethane.
3. All cable jackets shall be black unless specifically noted otherwise.
4. Cables shall be Lex Products “PowerFlex” or TMB “ProPlex” or approved equal.

F. Quantities per wiring device and accessory specifications, Drawings and Schedules.

2.14 PRODUCTION LIGHTING CONNECTORS

A. 20-Ampere Relay / Switched Circuit Production Connectors:
1. Connectors shall be 20 AMP “Edison” with integral strain relief. All connectors shall be black.
2. Male connectors shall be NEMA 5-15P.
3. Female connectors shall be NEMA 5-20R.
4. Panel mount receptacles shall be NEMA 5-20R DUPLEX.
5. Connectors by Hubbell, Leviton, Lex Products, or equal shall be acceptable.

B. 20-Ampere House Light / Work Light Connectors:
1. Connectors shall be NEMA L5-20 “Twist-Lock” with integral strain relief. All connectors shall be black.
2. Male connectors shall be Leviton 2311-B.
3. Female connectors shall be Leviton 2313-B.
4. Panel mount receptacles shall be Leviton 2310-B.
5. Equivalent connectors by Hubbell shall be acceptable.

C. 20-Ampere PowerCON Connectors:
1. Connectors shall be 20-AMP Neutrik “PowerCON” with integral strain relief. “PowerCON TRUE1” connectors shall be used only where specified or where required to mate with a specific fixture type.
2. Power in connectors shall be Neutrik NAC3FCA (blue).
3. Power out connectors shall be Neutrik NAC3FCB (grey).
4. Power in panel mount receptacles shall be Neutrik NAC3MPA-1 (blue).
5. Power out panel mount receptacles shall be Neutrik NAC3MPB-1 (grey).

D. 20-Ampere Neutrik TRUE1 Connectors:
1. Connectors shall be 20-AMP Neutrik “TRUE1” with integral strain relief. “PowerCON TRUE1” connectors shall be used only where specified or where required to mate with a specific fixture type.
2. Power in connectors shall be Neutrik NAC3MX-W-TOP.
3. Power out connectors shall be Neutrik NAC3FX-W-TOP.
4. Power in panel mount receptacles shall be Neutrik NAC3MPX-TOP.
5. Power out panel mount receptacles shall be Neutrik NAC3FPX-TOP.

E. Ethernet Connectors:
1. Ethernet connectors shall be RJ45, Neutrik “etherCON” with integral strain relief. All connectors shall be black.
2. Cable connectors shall be Neutrik NE8MC-B.
3. Panel mount receptacles shall be Neutrik NE8FDV-B.
4. Ethernet extension cables for fixtures or consoles that do NOT utilize “etherCON” panel mount receptacles shall be heavy-duty RJ45, Lex Products or approved equal.

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F. DMX Connectors:
1. DMX connectors shall be 5-pin XLR with integral strain relief. All connectors shall be black.
2. Male connectors shall be Neutrik NC5MXX-B.
3. Female connectors shall be Neutrik NC5FXX-B.
4. Male panel mount receptacles shall be Neutrik NC5MD-L-B-1.
5. Female panel mount receptacles shall be Neutrik NC5FD-L-B-1.

G. Quantities per lighting fixture specifications, accessory specifications, drawings and schedules.

2.15 PRODUCTION LIGHTING FIXTURES - LED

A. Color-Changing LED Profile Spotlights:
1. Color-Changing LED Profile Spotlights, each with: C-clamp, accessory frame, and safety cable.
2. Provide the following cables for each fixture:
a. One (1) minimum 3'-0" long Neutrik PowerCON pigtail with 15-AMP switched production lighting connector installed. Connector type as specified in this section.
b. One (1) 10'-0" long Neutrik PowerCON to Neutrik PowerCON power-thru cable.
c. Provide Neutrik "powerCON TRUE1" pigtails and cables for all fixtures provided with TRUE1 connectors.
d. One (1) 10'-0" long DMX cable.
3. The fixtures shall be of the manufacturers, styles and quantities indicated below, unless otherwise shown:
a. Chauvet Professional "Ovation E-910FC"
b. Electronic Theatre Controls "ColorSource Spot V"

Base Bid Quantity	Alternate EC-2 Quantity	Description
12	2	19° LED Profile
12	2	26° LED Profile
12	2	36° LED Profile
4	1	15° - 30° Zoom LED Profile
4	1	25° - 50° Zoom LED Profile

B. Color-Changing LED Wash Lights:
1. Color-Changing LED Wash Lights, each with: C-clamp, accessory frame, and safety cable.
2. Provide the following cables for each fixture:
a. One (1) minimum 3'-0" long Neutrik PowerCON pigtail with 15-AMP switched production lighting connector installed. Connector type as specified in this section.
b. One (1) 10'-0" long Neutrik PowerCON to Neutrik PowerCON power-thru cable.
c. Provide Neutrik "powerCON TRUE1" pigtails and cables for all fixtures provided with TRUE1 connectors.
d. One (1) 10'-0" long DMX cable.
3. The fixtures shall be of the manufacturers, styles and quantities as indicated below, unless otherwise shown:
a. Chauvet Professional "COLORado 2 Solo" with color-blending lens.

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b. Electronic Theatre Controls “ColorSource Fresnel V.”
c. Vari-Lite “VL600 Acclaim Fresnel+.”

Base Bid Quantity	Alternate EC-2 Quantity	Description
16	0	LED Wash Light

C. LED Strip Lights:
1. Color-Changing LED Strip Lights, each with: C-clamps, hanging arms, floor trunions, and safety cable.
2. Provide the following cables for each fixture:
a. One (1) minimum 3’-0” long Neutrik PowerCON pigtail with 15-AMP switched production lighting connector installed. Connector type as specified in this section.
b. One (1) 10’-0” long Neutrik PowerCON to Neutrik PowerCON power-thru cable.
c. Provide Neutrik “powerCON TRUE1” pigtails and cables for all fixtures provided with TRUE1 connectors.
d. One (1) 10’-0” long DMX cable.
3. The fixtures shall be of the manufacturers, styles and quantities as indicated below, unless otherwise shown:
a. A.C. Lighting “Chroma-Q Color Force II 72” with 80° x 30° cyc lens.
b. Chauvet Professional “COLORado Solo Bar 6” with cyc filter.

Base Bid Quantity	Alternate EC-2 Quantity	Description
0	0	LED Strip Lights

D. LED Work Lights:
1. White LED Work Lights, each with: C-clamp, safety cable and 20-AMP switched production lighting connector installed. Connector type as specified in this section.
2. The fixtures shall be of the manufacturers, styles and quantities indicated below, unless otherwise shown:
a. Meteor “Bolt Mini BLTM-200W-3000K-120V-NOD-WIDE-TRUE1-CCLAMP”
b. SSRC “WL-LED-200W” Warm White LED Work Light
c. Approved equal.

Base Bid Quantity	Alternate EC-2 Quantity	Description
6	0	LED Work Light

2.16 PRODUCTION LIGHTING FIXTURE ACCESSORIES

A. Extension Cables:
1. 12/3 SO jumpers with 20-AMP dimmed circuit production lighting connectors installed. Connector type as specified in this section.
a. Each cable shall have cable length indicated on a white background and covered with clear heat-shrink tubing 6” from each connector.

Base Bid Quantity	Alternate EC-2 Quantity	Description
4	0	5’-0” – Project Name

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4	0	10’-0” – Project Name
2	0	25’-0” – Project Name
0	0	50’-0” – Project Name
0	0	100’-0” – Project Name

2. 12/3 SO jumpers with 20-AMP switched circuit production lighting connectors installed. Connector type as specified in this section.
   a. Each cable shall have cable length indicated on a white background and covered with clear heat-shrink tubing 6” from each connector.

Base Bid Quantity	Alternate EC-2 Quantity	Description
4	0	5’-0” – Project Name
4	0	10’-0” – Project Name
2	0	25’-0” – Project Name
0	0	50’-0” – Project Name
0	0	100’-0” – Project Name

3. 12/3 SO jumpers with Neutrik PowerCON connectors installed. Connector type as specified in this section.
   a. Each cable shall have cable length indicated on a white background and covered with clear heat-shrink tubing 6” from each connector.

Base Bid Quantity	Alternate EC-2 Quantity	Description
4	0	5’-0” – Project Name
4	0	15’-0” – Project Name
2	0	25’-0” – Project Name
0	0	50’-0” – Project Name
0	0	100’-0” – Project Name

4. Marinco “Trixfer 3” or 12/3 molded “Y” two-fers, 36” long with 20-AMP dimmed production lighting connectors installed. Connector type as specified in this section.

Base Bid Quantity	Alternate EC-2 Quantity	Description
4	0	Two-fers

5. 12/3 SO adapters 12” long with connectors installed. Production lighting connector type as specified in this section.

Base Bid Quantity	Alternate EC-2 Quantity	Description

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2	0	20-AMP female receptacle per section to NEMA 5-15P
2	0	NEMA 5-20R to 20-AMP male plug per section

6. 12/3 SO Multiple 15-AMP 125 Volt Receptacle Extension Cord, 50'-0" long, with six (6) receptacles on 10' spacing, black. Lex Products "E-String 50112BA" or approved equal.

Base Bid Quantity	Alternate EC-2 Quantity	Description
0	0	Multiple-receptacle Extension

B. Production Lighting Hardware and Accessories:

Base Bid Quantity	Alternate EC-2 Quantity	Description
2	0	5'-0" DMX extension cord TMB Pro-cable or equal by Lex Products
2	0	15'-0" DMX extension cord TMB Pro-cable or equal by Lex Products
2	0	25'-0" DMX extension cord TMB Pro-cable or equal by Lex Products
1	0	50'-0" DMX extension cord TMB Pro-cable or equal by Lex Products
0	0	100'-0" DMX extension cord TMB Pro-cable or equal by Lex Product
0	0	Spare Color Frames – 5° City Theatrical #2329 or equal
0	0	Spare Color Frames – 10° City Theatrical #2328 or equal
0	0	Spare Color Frames – 14° or 70° or S4 Par City Theatrical #2487 or equal
12	0	Spare Color Frames – 19° to 50° City Theatrical #2350 or equal
12	0	Template Holder – A-Size City Theatrical #2150 or equal
12	0	Donut – 19° to 50° City Theatrical #2250 or equal
0	0	Drop-in Iris City Theatrical #2180 or equal

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Base Bid Quantity	Alternate EC-2 Quantity	Description
0	0	Top Hat – 10° City Theatrical #2452 or equal
0	0	Top Hat – 14° or 70° or S4 Par City Theatrical #2480 or equal
12	0	Top Hat – 19° to 50° – Tapered City Theatrical #2840 or equal
6	0	Short Hat – 19° to 50° – Tapered City Theatrical #2842 or equal
0	0	Concentric Ring Baffle for Pars City Theatrical #2484 or equal compatible with provided wash fixgture.
16	0	7” 8-way Barndoor for ETC Fresnels City Theatrical # 2568 or equal compatible with provided was fixture.
0	0	Safer Sidearm – 18” Single T City Theatrical #202 or equal
0	0	Safer Sidearm – 24” Double T City Theatrical #204 or equal
4	0	Steel Safer Sidearm (uses 1 ½” pipe) City Theatrical #210 w/ 24” pipe installed
0	0	50 pound Boom Base threaded for 1-1/2” I.D. pipe.
0	0	16’-0” long 1-1/2” I.D. Schedule 40 steel boom pipes, threaded both ends, painted flat black.
0	0	Boom Tie Off Ring installed on boom pipes above City Theatrical #1310 or equal
0	0	10-inch Weighted Base City Theatrical #4300 or equal
4	0	Clip Light with 40w blue A-lamp McMaster-Carr #1627K13 or equal
2	0	8” Adjustable wrench
24	0	Sheets Rosco color media
600’	0	Black cotton tie line - unwaxed

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Base Bid Quantity	Alternate EC-2 Quantity	Description
0	0	City Theatrical “DMXcat” with RJ45 adapter and belt pouch City Theatrical parts #6000, #6005 and #6009

C. Installation:
1. Installation shall be provided as described in the Installation article in Part 3 of this specification.

2.17 CONTROL CONSOLE

A. The system described below is based upon general performance criteria common to the products listed below. No other system shall be considered unless specifically approved by Schuler Shook at least ten (10) days prior to the bid date:
1. Electronic Theatre Controls “Element 2 – 1K”
2. Equal with prior approval

B. Physical Requirements:
1. Separate control processor unit, if required, shall be “tower” format. Integrated keyboard processor shall not be acceptable.
2. The console shall be deadfront, modular in construction, with plug-in control components, completely wired internally, and shall contain, but not be limited to, the following components:
3. Console shall allow for a minimum of two (2) full-size LCD monitors or touch screens for display and direct selection of console functions.
4. Minimum one (1) wheel for level adjustment and automated lighting control.
5. Keypad for patching, level setting, and cue recording.
6. Playback controls, including split crossfader.
7. Minimum forty (40) potentiometers for configurable channel or submaster control.
8. Hard drive for recording of all patch, submaster, and cue information.
9. USB ports to access external storage media for recording of all patch, submaster, and cue information.
10. USB ports to connect to peripherals (keyboard, mouse, etc.)

C. Operational requirements:
1. The console shall control a minimum of 1024 DMX outputs on a minimum of 10,000 channels.
2. A minimum of 10,000 cues shall be recorded, along with fade times, by means of a keypad.
3. Console shall be able to record part cues or have the ability to provide individual fade times for each channel.
4. Pile-on crossfades and overlapping scenes shall function on a highest-level-takes-precedence basis.
5. The console shall have a minimum of 1000 groups and 1000 effects.
6. It shall be possible to record and modify cues “blind.”
7. Control and programming features for automated fixtures shall include:
   a. A standard library of fixture profiles.
   b. The ability to copy and edit existing profiles and create new profiles.
   c. Patch displays including channel and output addressing.
   d. 16-bit fade resolution.
   e. Color characterization allowing color mixing.
   f. Easy selection of fixtures and attributes.
   g. Use of the wheel or encoders for quick adjustment of pan and tilt.

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D. In the event of a loss of power, an internal battery backup power supply shall hold all memory information for up to 24 hours.
E. Install in the control area.

2.18 CONTROL ACCESSORIES

A. Flat Screen Monitors.
   1. Provide 20-inch minimum color LCD monitors for use with main console to display patch, submaster, channel levels, and cue sheet. Monitors for consoles shall provide compatible touchscreen operation.
   2. Provide monitors as indicated in the Schedule of Quantities.
B. Dust Covers.
   1. Provide vinyl dust covers for all consoles and all monitors.
C. Storage Media.
   1. Provide appropriate spare storage media for control console. Removable flash media shall be a minimum of 2GB.
D. Task Lighting.
   1. Provide 18-inch LED task lighting fixtures with dimmers and weighted bases. Littlite LED or pre-approved equal.
   2. Provide one (1) 18XR-LED for each lighting console, verify console connector type.
   3. Provide additional LW-18-LED with dimmers and weighted bases per Schedule of Quantities.
E. Keyboard.
   1. Provide standard keyboard for any console that supports an external keyboard. Keyboard color: black.
   2. Provide standard keyboard for any remote video device that supports an external keyboard at the remote video location. Keyboard color: black.
F. Mouse.
   1. Provide standard mouse for any console that supports an external mouse. Mouse color: black.
   2. Provide standard mouse for any remote video device that supports an external mouse at the remote video location. Mouse color: black.

2.19 PORTABLE LIGHTING CONSOLE CART

A. The portable lighting console cart shall be the Wenger “Select Lab Workstation” with the following options:
   1. 62” wide desk surface.
   2. Adjustable height (includes bottom shelf).
   3. Graphite and black finish.
B. Cart finished dimensions shall be 62” wide x 30” deep x 28-31” tall. Cart shall be sized so that it may be easily moved by one person from the control room to the stage without removing the console. Verify all door and corridor widths (including door hardware and acoustic gaskets), elevator or lift dimensions, turning radii and other obstructions prior to fabrication. A cart that cannot be moved from control room to stage at the time of system commissioning shall be rejected.
C. Provide one (1) cart for the lighting console.
D. Install in the control room.

2.20 BOX BOOM OR TORMENTOR LIGHTING ASSEMBLIES

A. Pipe shall be nominal 1-1/2" I.D. Schedule 40 black steel pipe, ASTM A-120, stripped and painted with at least two coats of finish paint OR stripped and fully primed for field painting on site by others.
B. Provide and install two (2) tormentor lighting assemblies as follows:
   1. Assembly shall be welded construction, all welds to be ground smooth.
   2. Exposed pipe ends shall be cut cleanly, burrs removed, and all sharp edges eased or rounded.

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3. Assembly shall be firmly secured to the floor and to adjacent walls. Assume that in addition to fixture loads, technicians will climb on and lean ladders against these assemblies.
4. Assemblies mounted to an elevated floor surface shall include a standard +4" tall toe kick.
5. Horizontal fixed pipes, if required, shall be located at +42" AFF for use as a guardrail unless otherwise noted.
6. Adjustable pipes shall be supported with right angle pipe clamps with factory applied black finish:
   a. The Light Source "Mega 90 Degree Fixed Coupler #ML9B."
   b. Rose Brand "Fixed Cheeseborough #HWCH0008."
   c. Sapsis Rigging "Dual Purpose Fixed Right Angle Pipe Clamp #04-07-82-105F."
   d. Approved equal.

C. Assembly shall be fully primed and painted "black" with a satin sheen. Confirm color with architect prior to painting.
D. Coordinate blocking or other requirements with related trades.
E. Fabricate and install as shown on the Drawings and Schedules.

2.21 SCHEDULE OF QUANTITIES

ARTICLE	DESCRIPTION	QUANTITY SUPPLIED
2.2	DMX-Controlled Relay Panel – (24) 20 AMP Relays	1
2.3	DMX-Controlled Breaker Panel – (48) 20 AMP Relays	1
2.4	Control Interface Rack	1
2.5	Power Conditioners with Battery Back-up	1
2.6	Network Data System	Per Specification and Drawings
2.7	Centralized DMX Distribution	Per Drawings and Schedules
2.8	Control Receptacle Panels	Per Drawings and Schedules
2.9	Architectural Lighting Control Processors	1
2.10	Houselight Panels – LCD	1
	Houselight Panels – LCD Portable	1
2.11	Entry Stations	Per Drawings and Schedules
2.12	Wiring Devices	Per Drawings and Schedules
2.13	Production Lighting Cables	Per Specification and Schedules
2.14	Production Lighting Connectors	Per Specification and Schedules
2.15	Production Lighting Fixtures	Per Specification

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ARTICLE	DESCRIPTION	QUANTITY SUPPLIED
2.16	Production Lighting Fixture Accessories	Per Specification
2.17	Control Console	1
2.18	Monitors – LCD Touch Screen	2
	Dust Covers	Per Specification
	Storage Media	2
	Task Lights	2
	Keyboard	1
2.19	Portable Console Cart	1
2.20	Box Boom or Tormentor Lighting Pipe Assemblies	Per Specifications and Drawings

PART 3 – EXECUTION

3.01 FABRICATION

A. Control desks, racks, and cabinets shall be welded assemblies of sheet steel or aluminum or bar size angles, channels, and tees or aluminum extrusions forming rigid enclosures to support internal components.
B. Operating elements shall be mechanically safe and electrically “dead.”
C. All steel parts and panels shall be cleaned and primed with rust inhibiting primer. Exterior finishes shall be epoxy resin or baked enamel in matte black, or in Manufacturer’s standard color where not specified.
D. Control element working face panels shall be steel or substantial aluminum. Legends and control and protective device designations shall be engraved in panels, or in permanently attached plates, and located for ready identification.
E. All internal wiring shall be factory completed. All wiring shall be in harnesses and bound. No loose or randomly routed wires shall be permitted.
F. All wire sizes and insulations shall comply with NFPA 70 National Electric Code (NEC), UL, and local codes and meet or exceed electronics industry standards.

3.02 PACKING AND SHIPPING

A. Equipment shall be wrapped and sealed in polyethylene and substantially crated for shipment. Crates shall clearly indicate equipment contained, nature of components, and site designation.
B. Dimmers shall be individually packaged.
C. The equipment manufacturer shall provide notice prior to shipping of shipping method and equipment contained.

3.03 INSTALLATION

A. Refer to the Division of Responsibility Matrix on the Drawings. (Compare matrix with language below.)
B. All electrical feeds, conduit, and wire shall be provided and installed by Division 26.
C. All production lighting dimmer racks, relay panels, distribution, and control devices specified in this Section shall be provided by the Contractor and installed by Division 26.
D. All receptacles at all distribution devices shall be tested by the Contractor to verify that every circuit has been terminated at the correct dimmer rack, relay panel or panelboard. Circuit corrections, if required, shall be completed by Division 26 prior to Owner training.
E. All control wire types and topography shall be detailed by the Production Lighting

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Equipment Manufacturer in the shop drawings. Control wire shall be provided and installed by Division 26. Control wire testing and termination shall be completed by Division 26 and coordinated with the Contractor.

F. After all painting and dust-creating work is complete and the venue has been thoroughly cleaned, the Contractor shall unpack, assemble, install and test all portable equipment; including consoles, fixtures and accessories specified in this Section.

G. All lighting fixtures shall be hung by the Contractor at locations indicated by the Owner or Schuler Shook prior to Owner training.
   1. Fixtures shall be fully assembled, shutters pulled to “open” position, aimed towards stage, safety cables installed, and plugged to the nearest circuit.
   2. All fixtures shall be addressed and patched to facilitate Owner training.
   3. Installation of color or accessories is the responsibility of the Owner.
   4. Final aiming of all fixtures provided by this section is the responsibility of the Owner.

3.04 SYSTEMS INTEGRATION AND PROGRAMMING

A. Contractor shall provide addressing for all LED fixtures and any other DMX controlled fixture. Contractor to provide Division 26 contractor a list of DMX address numbers prior to installation of fixtures. At time of commissioning Contractor to patch all DMX controlled fixtures and test to ensure proper functionality.

B. Contractor shall install the most current LED fixture profiles at each control console and train the owner to add and update fixture profiles during the Owner training required herein.

C. Contractor, at the direction of Schuler Shook and/or owner’s representative, will adjust all programmable components of the lighting and control system to meet the design intent of the project. Programmable devices include lighting controls (including the layout and design of all touchscreen control panels), addressable lighting fixtures, and user interfaces.

D. Contractor to plan for a minimum of three (3) hours of dedicated programming time on site with Schuler Shook to program LED lighting shows or effects. This time is in addition to any initial time required for system set-up.

E. Contractor to coordinate any connection to A/V system with A/V contractor and work with A/V programmer to provide desired cross platform functionality.

3.05 PROTECTION AND CLEANING

A. Provide protection for any production lighting equipment, panels and faceplates installed prior to the completion of construction and painting. Remove any debris or paint from equipment that was not adequately protected. Panels and faceplates not appearing “like new” shall be replaced.

B. No control consoles, fixtures or accessories shall be installed until construction and painting are complete and the building has been cleaned. Any consoles, fixtures or accessories delivered to the job site prior to their installation shall be stored in a clean area in dustproof bags.

C. Upon the completion of the work of this Section, dispose of all packing materials, debris and remnants which result from the work of this Section.

END OF SECTION

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SECTION 262200
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General purpose transformers.

1.02 RELATED REQUIREMENTS

A. Section 033000 - CAST-IN-PLACE CONCRETE: Concrete equipment pads.

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: Flexible conduit connections.

E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

F. Section 262416 - Panelboards.

1.03 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2025.

C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.

F. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

G. NEMA ST 20 - Dry Type Transformers for General Applications; 2021.

H. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; 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 required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

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

B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
   1. Vibration Isolators: Include attachment method and rated load and deflection.

C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

E. Field Quality Control Test Reports.

F. Maintenance Data: Include recommended maintenance procedures and intervals.

G. Project Record Documents: Record actual locations of transformers.

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 in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
   1. Greater than 10 kVA: 104 degrees F maximum.
   2. Less than 10 kVA: 77 degrees F maximum.

1.09 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

E. Substitutions: See Section 016000 - Product Requirements.

F. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
   1. Altitude: Less than 3,300 feet.
   2. Ambient Temperature:
      a. Greater than 10 kVA: Not exceeding 104 degrees F.
      b. Less than 10 kVA: Not exceeding 77 degrees F.

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
   2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

C. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

D. Winding Taps:
   1. Less than 3 kVA: None.
   2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
   3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
   4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

E. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

F. Sound Levels: Standard sound levels complying with NEMA ST 20

G. Mounting Provisions:
   1. Less than 15 kVA: Suitable for wall mounting.
   2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
   3. Larger than 75 kVA: Suitable for floor mounting.

H. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 2.
      b. Outdoor locations: Type 3R.
   2. Construction: Steel.
      a. Less than 15 kVA: Totally enclosed, non-ventilated.

b. 15 kVA and Larger: Ventilated.

3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

I. Accessories:
1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.04 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 260533.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Install transformers plumb and level.

G. Transformer Support:
1. Provide required support and attachment in accordance with Section 260529, where not furnished by transformer manufacturer.
2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
3. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

H. Provide grounding and bonding in accordance with Section 260526.

I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

K. Identify transformers 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 Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

3.04 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

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

3.05 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262200

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SECTION 262413.11
SWITCHBOARDS - SCHNEIDER ELECTRIC SQUARE D FLEXSET / QED-2

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-voltage switchboards.

B. Overcurrent protective devices.

1.02 RELATED REQUIREMENTS

A. Section 033000 - CAST-IN-PLACE CONCRETE: Concrete equipment pads.

B. Section 260160.23 - Digital Modeling and Monitoring Services - Schneider Electric Digital Twin.

C. Section 260573.10 - Power System Studies - Schneider Electric.

D. Section 260913.33 - Electrical Power Management System - Schneider Electric Square D EcoStruxure Power Operation.

E. Section 260913.83 - Condition Monitoring Services - Schneider Electric Square D EcoStruxure Asset Advisor.

F. Section 262713.13 - Power and Energy Meters - Schneider Electric PowerLogic.

G. Section 262713.16 - Power Quality Meters - Schneider Electric PowerLogic.

H. Section 262813 - Fuses: Fuses for fusible switches.

1.03 ABBREVIATIONS AND ACRONYMS

A. EMI: Electromagnetic interference.

B. EPMS: Electrical power management system.

C. ERMS: Energy reduction maintenance setting.

D. RFI: Radio-frequency interference.

E. SPD: Surge protective device.

1.04 DEFINITIONS

A. Switchboards may also be identified as SWBD.

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. MIL-STD-220 - Method of Insertion Loss Measurement; 2009c (Validated 2024).

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

G. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.

H. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.

I. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 1000 Volts or Less; 2023.

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. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. NFPA 70E - Standard for Electrical Safety in the Workplace; 2027.

N. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

O. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

P. UL 891 - Switchboards; Current Edition, Including All Revisions.

Q. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

R. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.06 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Review material selections and installation procedures with Owner, Engineer, manufacturer's representative, and affected installers.

B. Scheduling: Do not schedule functional demonstration testing until operational readiness testing is complete and associated report and certification have been submitted.

C. 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 switchboards, 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 dimensioned plan and elevation views of switchboards; indicate dimensions, weights, shipping splits, and required clearances.
   2. Include single-line diagram.

F. Operational Readiness Report:
   1. Document test results, including assumptions, conditions, allowances, and corrections made.
   2. Provide listing of field modifications and adjustments made including settings/parameters not identified as factory defaults within equipment’s operations and maintenance manual documentation.
   3. Include certification, signed by Contractor and manufacturer's representative, that equipment and associated system have been installed, configured, and tested in accordance with manufacturer’s recommendations, conforms to requirements of Contract Documents, and is ready for operation.

G. Manufacturer's qualification statement.

H. Operation and Maintenance Data:
   1. Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
      a. Include manufacturer’s standard operation and maintenance data assembled for each size and type of equipment furnished.
   2. Digital Record Keeping:
      a. Provide maintenance logbook application/website available on PC/mobile device to assist in compliance with NFPA 70B.
      b. Include access to manufacturer's standard documentation, equipment serial number, as-built drawings, assembly and testing results, device settings, and spare parts list.
      c. Provide password-protected access to Owner.
      d. Provide access via scannable QR code on front face of equipment.

I. Executed warranty.

J. 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.
   3. Digitized network operational model, updated to as-installed and commissioned state.

K. 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 switchboard 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 20 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.

C. Installer Qualifications: Firm with minimum 10 years of experience with equipment of similar type and scope.

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 FlexSeT or QED-2 per project requirements; 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 LOW-VOLTAGE SWITCHBOARDS

A. Basis of Design: Schneider Electric; Square D FlexSeT or QED-2 per project requirements; www.se.com/#sle.

B. Switchboard Ratings/Configurations: As indicated on drawings.

C. Switchboard Assemblies:
   1. Comply with NEMA PB 2; list and label as complying with UL 891.
   2. Provide front and rear alignment of adjacent sections.

D. Short Circuit Current Rating: Where not specified, provide switchgear with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

E. Cable Terminations for Incoming Conductors:
   1. Provide lugs in quantity and size required for conductors indicated on drawings.
   2. Lug Type: Aluminum mechanical lugs, suitable for terminating aluminum or copper conductors unless otherwise indicated; rate for 167 degrees F.

F. Bussing:
   1. Bus Density Rating: Standard, in accordance with UL 891 temperature rise requirements.
   2. Bus Material: Hard-drawn, silver-plated copper of 98 percent conductivity unless otherwise indicated.
   3. Plating: Apply to bus surfaces except cut edges. Plating on contact surfaces only is not permitted.
   4. Phase and Neutral Horizontal Bus: Ampacity equal to or greater than switchboard system rating. Tapered bus is not permitted.
   5. Group-Mounted Feeder Vertical Bus Stack:
      a. Provide capability to mount feeder breakers with different frame sizes/poles across from one another on bus stack.
      b. Design to remove nonconducting surface films during circuit breaker installation by wiping action of circuit breaker jaws.
      c. Design in conjunction with circuit breaker jaws to create blow-on forces under fault conditions.
      d. Bolted connections for group-mounted feeder breakers are not permitted.
   6. Ground Bus:
      a. Size in accordance with NFPA 70 and UL 891.
      b. Bus Material: Hard-drawn copper of 98 percent conductivity.
      c. Equip with pressure connectors for feeder and branch circuit equipment grounding conductors.

G. Enclosures:
   1. Construction: Steel.
   2. UL 50E Rating, Unless Otherwise Indicated:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Indoor Locations with Fire Sprinkler Protection: Type 1 with drip hood.
      c. Outdoor Locations: Type 3R.
   3. Front Covers: Removable with single tool.
   4. Doors: Hinged with removable hinge pins.
   5. Finish: Manufacturer's standard paint color over rust-inhibiting primer on treated metal surface.

H. Future Provisions:
   1. Future Switchboard Sections: Equip horizontal bus with splicing hardware for additional switchboard sections.
   2. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit breaker compartment.

I. Markings and Labeling:

1. Provide identification and warning labels/nameplates exterior to equipment resistant to weather, UV, and intended installation environment.
2. 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.
3. Provide scannable QR code on front face of equipment for access to maintenance logbook application/website available on PC/mobile device.

J. Maintenance Mode Switches:
1. Description: Local, lockable switch with blue status indicator light that permits selection of maintenance mode with alternate electronic trip unit settings for reduced fault clearing time in accordance with NFPA 70.
2. Provide for circuit breakers 1,200 A and larger and where indicated on drawings, unless providing other means of reducing clearing time in accordance with NFPA 70.
3. Switch Type: Provide energy reduction maintenance settings (ERMS) switches or maintenance mode settings (MMS) switches as indicated.
   a. ERMS Switches: Clearing time of less than 50 milliseconds when activated.
   b. MMS Switches: Clearing time of less than 80 milliseconds when activated.

K. Surge Protective Device (SPD):
1. See Section 26 4313 for additional information.
2. Factory installed, integrated within switchboard.
3. Listed as complying with UL 1449.
4. Surge Current Rating: Not less than 240 kA per phase.
5. Voltage: Match switchboard nominal system voltage.
6. Protected Modes:
   a. Wye Systems: L-L, L-N, L-G, and N-G.
   b. Delta Systems: L-L and L-G.
7. Protection Circuits: Modular, field replaceable.
8. Fuse each mode, including N-G, with 200 kA IR, UL-classified, surge-rated fuse; incorporate thermal cutout device.
9. EMI/RFI Filtering: Listed as complying with UL 1283; minimum 50 dB at 100 kHz with insertion ratio of 50 to 1 in accordance with MIL-STD-220.
10. Diagnostics:
    a. Audible Alarm: Activate upon fault condition with switches for alarm silence and testing.
    b. Remote Status Monitoring: One set of normally open/normally closed dry contacts.
    c. Surge Counter: Six-digit, indicate total transient surges that deviate from sine wave envelope by more than 125 V.
11. Provide integral UL-recognized disconnect switch where not connected to dedicated circuit breaker.
12. Products:
    a. Schneider Electric SurgeLogic IMA series.

L. Power Metering:
1. Factory installed, integrated within switchboard.
2. Applications:
   a. Low-Voltage Mains: Power and energy meter.
   b. Low-Voltage Feeders: Power and energy meter or electronic trip unit feeder breaker metering.
3. Power and Energy Meters:
   a. See Section 262713.13 for additional information.

b. Capable of monitoring for network management, energy cost allocation, asset management, operational efficiency, and compliance reporting.
c. Products:
1) Schneider Electric PowerLogic PM5563 Meter.

M. Communications:
1. Provide internal wired communications network for connection to Owner's network for power monitoring and equipment status/alarm information via:
a. Connection to building management system, electrical power management system (EPMS), or other software.
b. Access to each breaker's embedded web pages through standard web browser for maintenance review, troubleshooting, and monitoring.
2. Communications Protocol: Ethernet Modbus TCP/IP network connected via daisy-chain architecture from each circuit breaker and separate meters (where specified) upstream to switchboard Ethernet port.
3. Provide software for adjusting circuit breaker trip/alarm points, displaying trip curves, and updating firmware.
4. Internal Network Wiring: Shielded cables with pluggable connectors to facilitate connection across shipping splits.

N. 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. Internal wired communications network for multiple sections/devices to provide single point of connection to EPMS network.
c. Compliance with recognized cybersecurity requirements.
d. Breaker aging modeling for electronic trip circuit breakers.
e. Remote EPMS capability for equipment configuration, electrical power monitoring, power quality monitoring, compliance, and correction; alarm monitoring with event log.
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 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
1. Interrupting Capacity: As required to provide short circuit current rating indicated.
2. Insulated Case Circuit Breakers (ICCBs):
a. Description: Quick-make, quick-break circuit breakers with two-step stored energy closing mechanism; maximum five-cycle closing time.
b. Listed and labeled as complying with UL 489.
c. Construction:
1) Provide fixed-mount circuit breakers unless otherwise indicated.
d. Electronic Trip Units:

1) Microprocessor based, with circuit breaker status display and LED trip indicators.
2) Provide energy reduction maintenance settings (ERMS).
3) Provide network monitoring capability for amperage, voltage, power, energy, and harmonics.
4) Provide capability to upgrade by uploading digital modules without requiring replacement/modification of hardware.
5) Where indicated on drawings, provide electronic trip units with field-adjustable long-time and instantaneous protection settings.

e. Products:
1) Schneider Electric; MasterPact MTZ series.
2) Substitutions: See Section 016000 - Product Requirements.

3. Molded Case Circuit Breakers (MCCBs):
a. Comply with FS W-C-375; listed and labeled as complying with UL 489.
b. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
c. Circuit Breaker Type:
1) Provide thermal magnetic circuit breakers unless otherwise indicated.
2) Provide electronic trip circuit breakers where indicated.
d. Electronic Trip Units:
1) Microprocessor based, with circuit breaker status display and LED trip indicators.
2) Where indicated on drawings, provide electronic trip units with field-adjustable long-time and instantaneous protection settings.
3) Provide network monitoring capability for amperage, voltage, and power where indicated.
e. Provide the following where indicated or required:
1) Shunt Trip: Provide 120 VAC coil, energized from separate circuit.
2) Auxiliary Contacts: One SPDT switch for indicating status of circuit breaker contacts.
3) Ground Fault Protection: Integral to circuit breaker with adjustable pickup and time delay settings, push to test feature, and ground fault indicator.
f. Products:
1) Schneider Electric; PowerPacT series.

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, including:
1. Verify concrete pads are level and free of irregularities.
2. Verify installation space is enclosed and weatherproof.
3. Verify wet work located in or in close proximity to switchboard installation location is completed and dry.
4. Verify work above ceilings is complete.

3.02 INSTALLATION

A. Install equipment in accordance with manufacturer’s written instructions.

B. Install switchboards in accordance with NECA 1, NECA 400, and NEMA PB 2.1.

C. Unless otherwise indicated, install and anchor switchboards on raised concrete pad 4 inches high; see Section 033000.

D. Set field-adjustable circuit breaker tripping function settings as determined by coordination study.

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.
   3. Identify switchboards with label indicating inspection/testing agency and date of service.

C. Operational Readiness Testing:
   1. Inspect and test equipment and associated systems for conformance to Contract Documents, including equipment manufacturer’s recommendations, and readiness for operation.
      a. Visually inspect for physical damage and proper installation.
      b. Perform tests in accordance with manufacturer's instructions.
      c. Perform tests to verify compliance with Contract Documents.
      d. Perform tests to verify equipment is ready for operation.
      e. Touch-up paint chips and scratches with manufacturer-supplied paint.
      f. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
      g. Measure, using high potential testing, insulation resistance of each bus structure phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1,000 VDC.
         1) Comply with manufacturer's documented specific testing procedures.
         2) Minimum Insulation Resistance: 1 megohm.
      h. Physically test key interlock systems for proper functionality prior to energizing.
      i. Test continuity of each circuit.
      j. Perform each electrical test and visual/mechanical inspection listed in NETA ATS as applicable. Certify compliance with test parameters.
         1) Switchboards: See Section 7.1.
         2) Fusible Switches: See Section 7.5.
         3) Circuit Breakers: See Section 7.6.
         4) Relays: See Section 7.9.
         5) Instrument Transformers: See Section 7.10.
         6) Meters: See Section 7.11.
         7) Ground Fault Protection Systems: See Section 7.14.

D. Correct deficiencies and replace damaged or defective switchboards or associated components.

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: Demonstrate proper operation of switchboards and associated systems to Owner's designated representative and Engineer, observing and documenting compliance with Contract Documents.

D. Training:
   1. Train Owner's personnel on operation and maintenance of system.
      a. Accommodate minimum of four attendees.
      b. Provide not less than one session(s) with four hours of classroom and hands-on training.
      c. Training Reference: Use submitted operations and maintenance manuals.
      d. Instructor: Factory-trained manufacturer's representative.
      e. Location: Project site.
   2. Provide sufficient time and detail in each session to cover the following at minimum:
      a. Operation theory.
      b. Major equipment components.
      c. Equipment operation.
      d. Equipment configurations.
      e. Maintenance, troubleshooting, and repair.
      f. Component-level parts replacement.

3.05 PROTECTION

A. Protect installed switchboards 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 262413.11

SECTION 262416.11
PANELBOARDS - SCHNEIDER ELECTRIC SQUARE D NQ / NF

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Lighting and appliance panelboards.

B. Molded case circuit breakers.

1.02 RELATED REQUIREMENTS

A. Section 260573.10 - Power System Studies - Schneider Electric.

B. Section 260913.33 - Electrical Power Management System - Schneider Electric Square D EcoStruxure Power Operation.

C. Section 260913.83 - Condition Monitoring Services - Schneider Electric Square D EcoStruxure Asset Advisor.

D. 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; 2027.

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: two for each lock.
   3. Spare Parts: For each type and size of unit installed.
      a. Provide minimum spare parts recommended by manufacturer.
      b. Package and mark spare parts for long-term storage.

4. 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. 480Y/277 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) 480Y/277 VAC:
            (a) Series Rated: 18 kA.
      e. Circuit Breaker Orientation:
         1) 480Y/277 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 galvannealed 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 and aluminum conductors.
      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.

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. Branch Circuit Breakers in 480Y/277 VAC Panelboards:

a. Mounting: Bolt on to bus, without requiring additional external mounting hardware.
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 100 A in 600Y/347 VAC panelboards.
3) 3-Pole Breakers: From 15 A to 125 A; up to 100 A in 600Y/347 VAC panelboards.
c. Products:
1) Schneider Electric; Square D E-Frame series.

5. 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.
6. Lugs:
a. Listed to accept solid or stranded copper and aluminum conductors.
b. Listed to accept 75 degree C rated wire.
7. 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 262416.11

SECTION 262713.16
POWER QUALITY METERS - SCHNEIDER ELECTRIC POWERLOGIC

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 - Schneider Electric Square D EcoStruxure Power Operation.

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 Characteristiscs 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.
      a. Include manufacturer, supplier, support, and repair center contact information.
      b. Include manufacturer’s standard operation and maintenance data assembled for each size and type of equipment furnished.

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.

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.

D. Electrical Power Management System Capabilities:
   1. 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. Remote EPMS capability for equipment configuration, electrical power monitoring, power quality monitoring, compliance, and correction; alarm monitoring with event log.
   2. 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 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.

END OF SECTION 262713.16

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SECTION 262726
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Wall plates.

D. Floor box service fittings.

E. Poke-through assemblies.

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; 2015.

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. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
   6. 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.

F. Wiring Devices Installed on generator power: Red with stainless steel wall plate.

G. Access Floor Boxes: White wiring devices with Stainless steel cover with insert to match floor covering.

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; 50% 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 and 50% split controlled receptacle permanent marking label on device per NFPA70; single duplex or quad as indicated on drawings.
   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.

2.06 FLOOR BOX SERVICE FITTINGS

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell.com/#sle.
   2. Thomas & Betts Corporation: www.tnb.com/#sle.
   3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Service fittings compatible with floor boxes provided under Section 260533.16 with components, adapters, and trims required for complete installation.

C. Flush Floor Service Fittings:
   1. Single Service Flush Convenience Receptacles:
      a. Cover: Round.
      b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
   2. Accessories:
      a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
      b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.
   3. Products:
      a. Hubbell Incorporated: www.hubbell.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.

2.07 POKE-THROUGH ASSEMBLIES

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell.com/#sle.
   2. Thomas & Betts Corporation: www.tnb.com/#sle.
   3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.

B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

C. Flush Floor Service Fittings:
   1. Single Service Flush Convenience Receptacles:
      a. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
   2. Accessories:
      a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

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. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

J. Install wiring devices plumb and level with mounting yoke held rigidly in place.

K. Install wall switches with OFF position down.

L. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

M. 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.

N. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

O. Identify wiring devices in accordance with Section 260553.

P. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

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 262726

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 262813

SECTION 262816.13
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260529 - Hangers and Supports for Electrical Systems.

C. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

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 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.04 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of circuit breaker upon request.

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.

D. Manufacturer's equipment seismic qualification certification.

E. Project Record Documents: Record actual installed locations of enclosed circuit breakers.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 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 circuit breaker internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

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 23 degrees F and 104 degrees F.

D. Short Circuit Current Rating:
   1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
   2. Label equipment utilizing series ratings as required by NFPA 70.

E. Conductor Terminations: Suitable for use with the conductors to be installed.

F. Provide electronic trip circuit breakers for circuit breaker frame sizes 400 amperes and above.

G. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

H. 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:

I. Provide externally operable handle with means for locking in the OFF position.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:
   1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
   2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

C. Conductor Terminations:
   1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

D. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

E. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

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 circuit breakers plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers 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. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 260573.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements, for additional requirements.

B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than _____ amperes. Tests listed as optional are not required.

D. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

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 circuit breaker enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262816.13

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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; 2015.

B. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

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. 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.

E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

F. 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: Aluminum, suitable for terminating aluminum or copper conductors.
   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 262816.16

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.

D. Utility Interconnection:
   1. Prepare and submit documentation as required for securing utility interconnection agreement between Owner and Utility Company.
      a. Include copies of documentation with submittals.
   2. Preinstallation Meeting: Convene one week prior to commencing work of this section to review interconnection requirements and details with Utility Company representative.
   3. Coordinate with Utility Company to provide utility metering suitable for system requirements.
   4. Arrange for inspections and secure permits necessary to obtain Utility Company approval of system.

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. Utility interconnection documentation.

L. Field quality control test reports.
   1. Include manufacturer's field reports.

M. 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.

N. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

O. Maintenance contracts.

P. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

Q. Software: One copy of software provided under this section.

R. 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. Comply with Utility Company requirements for interconnection.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. 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.

E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
   1. Contract maintenance office located within 50 miles of project site.

F. 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Photovoltaic Modules, Crystalline Silicon:
1. CW Energy - (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. Unirac, Inc: www.unirac.com/#sle (Basis of Design)
2. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com/#sle.
3. Direct Power and Water Corporation: www.dpwsolar.com/#sle.
4. Metal Roof Innovations, Ltd. S-5! Attachment Solutions; S-5! PV Kit: www.s-5.com/#sle.
5. PHP Systems/Design: www.phpsd.com/#sle.
6. TRA Snow and Sun: www.trasnowandsun.com/#sle.
7. Substitutions: See Section 016000 - Product Requirements.

C. Photovoltaic Combiner Boxes:
1. Enphase; 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. Solaredge (Basis of Design)
2. Schneider Electric: www.se.com/#sle.
3. SMA America, LLC: www.sma-america.com/#sle.
4. Solectria Renewables, LLC: www.solectria.com/#sle.
5. 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).

C. Basis of Design: CTW450-108TNB10 450 Wp or equal.

D. Substitutions: See Section 016000-Product Requirements.

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: Up to 10 degrees.
   d. Provide minimum clearance of 3 inches between roof and module for air circulation and drainage.
   e. Products:
      1) UNIRAC RM10 EVO (Basis of Design) or equal.
      2) Substitutions: See Section 016000 - Product Requirements.

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.
6. Product: Enphase Energy X-IQ-AM1-240-5/X-IQ-AM1-240-5-HDK or equal.

C. Photovoltaic Junction Boxes:
1. Diecast aluminum metal box suitable for mounting on solar array racking system.
2. Gasketed weahtertight 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 rterminate 600V PV free-air wiring and THWN-2 wiring.
5. Product: Enphase Energy or equal.

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.
f. SOLAREDGE SE120KUS (Basis Of Design) or Equal.

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. 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. Install photovoltaic system in accordance with NECA 412.

D. Provide required support and attachment in accordance with Section 260529.

E. 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.

F. 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.

G. 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.

H. 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 263100

SECTION 263213
ENGINE GENERATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:
   1. Engine and engine accessory equipment.
   2. Alternator (generator).
   3. Generator set control system.
   4. Generator set enclosure.

1.02 RELATED REQUIREMENTS

A. Section 033000 - CAST-IN-PLACE CONCRETE: Concrete equipment pads.

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.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.

C. NEMA MG 00001 - Motors and Generators; 2024.

D. NFPA 30 - Flammable and Combustible Liquids Code; 2024, with Errata (2025).

E. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2024, with Amendment.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 99 - Health Care Facilities Code; 2024.

H. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.

I. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

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, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
   1. Include generator set sound level test data.
   2. Include characteristic trip curves for overcurrent protective devices upon request.
   3. Include alternator thermal damage curve upon request.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
   1. Identify mounting conditions required for equipment seismic qualification.

D. Manufacturer's equipment seismic qualification certification.

E. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

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 factory emissions certification.

J. Source quality control test reports.

K. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
   1. Certified prototype tests.
   2. Torsional vibration compatibility certification.
   3. NFPA 110 compliance certification.
   4. Certified rated load test at rated power factor.

L. Manufacturer’s detailed field testing procedures.

M. Field quality control test reports.

N. 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.

O. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

P. Maintenance contracts.

Q. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

R. 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 the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.

3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
4. NFPA 30 (Flammable and Combustible Liquids Code).

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

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

E. 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 generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

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 MANUFACTURERS

A. Packaged Engine Generator Set:
1. Caterpillar Inc: www.cat.com/#sle.
2. Cummins Power Generation Inc: www.cumminspower.com/#sle.
3. Kohler Co: www.kohlerpower.com/#sle.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:
1. Application: Emergency/standby.
2. Configuration: Single packaged engine generator set operated independently (not in parallel).

D. Packaged Engine Generator Set:
1. Type: Gaseous (spark ignition).

2. Power Rating: 200 kW, standby.
3. Voltage: 480Y/277 V, 3 phase, 60 Hz.
4. Main Line Circuit Breaker:
   a. Type: Thermal magnetic.
   b. Trip Rating: Select according to generator set rating.

E. Generator Set General Requirements:
1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
2. Factory-assembled, with components mounted on suitable base.
3. List and label engine generator assembly as complying with UL 2200.
4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

G. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
4. Maximum Load Step: Supports 100 percent of rated load in one step.

H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Interface with building automation system as specified in Section 230923.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Gaseous (Spark Ignition):
1. Fuel Source: Natural gas.
2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
   a. Carburetor.
   b. Gas pressure regulators.
   c. Fuel shutoff control valves.
   d. Low gas pressure switches.

C. Engine Starting System:

1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
   a. Battery Type: Lead-acid.
   b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
   c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
   c. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
   d. Provide integral DC output ammeter and voltmeter with five percent accuracy.
   e. Provide alarm output contacts as necessary for alarm indications.

D. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.

G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

2.04 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 00001; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:
1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.

3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 00001, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 00001, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

2.05 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
2. Generator Set Control Functions:
a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
3. Generator Set Status Indications:
a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
b. Current (Amps): For each phase.
c. Frequency (Hz).
d. Real power (W/kW).
e. Reactive power (VAR/kVAR).
f. Apparent power (VA/kVA).
g. Power factor.
h. Duty Level: Actual load as percentage of rated power.
i. Engine speed (RPM).
j. Battery voltage (Volts DC).
k. Engine oil pressure.
l. Engine coolant temperature.
m. Engine run time.
n. Generator powering load (position signal from transfer switch).
4. Generator Set Protection and Warning/Shutdown Indications:
a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
1) Overcrank (shutdown).
2) Low coolant temperature (warning).
3) High coolant temperature (warning).
4) High coolant temperature (shutdown).
5) Low oil pressure (shutdown).
6) Overspeed (shutdown).
7) Low fuel level (warning).
8) Low coolant level (warning/shutdown).

9) Generator control not in automatic mode (warning).
10) High battery voltage (warning).
11) Low cranking voltage (warning).
12) Low battery voltage (warning).
13) Battery charger failure (warning).

b. In addition to NFPA 110 requirements, provide the following protections/indications:
1) High AC voltage (shutdown).
2) Low AC voltage (shutdown).
3) High frequency (shutdown).
4) Low frequency (shutdown).
5) Overcurrent (shutdown).

c. Provide contacts for local and remote common alarm.
d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:
a. Event log.

C. Remote Annunciator:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Generator Set Status Indications:
a. Generator powering load (via position signal from transfer switch).
b. Communication functional.
3. Generator Set Warning/Shutdown Indications:
a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following indications:
1) Overcrank (shutdown).
2) Low coolant temperature (warning).
3) High coolant temperature (warning).
4) High coolant temperature (shutdown).
5) Low oil pressure (warning).
6) Low oil pressure (shutdown).
7) Overspeed (shutdown).
8) Low fuel level (warning).
9) Low coolant level (warning/shutdown).
10) Generator control not in automatic mode (warning).
11) High battery voltage (warning).
12) Low cranking voltage (warning).
13) Low battery voltage (warning).
14) Battery charger failure (warning).

b. Provide audible alarm with silence function.
c. Provide lamp test function that illuminates all indicator lamps.

2.06 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating, weather protective.

B. Enclosure Material: Steel or aluminum.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.

I. Utilize an upward discharging radiator hood.

J. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

2.07 SOURCE QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements, for additional requirements.

B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

C. Generator Set production testing to include, at a minimum:
   1. Operation at rated load and rated power factor.
   2. Single step load pick-up.
   3. Transient and steady state voltage and frequency performance.
   4. Operation of safety shutdowns.

D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

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. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 033000.

F. Provide required support and attachment in accordance with Section 260529.

G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

H. Provide engine exhaust piping in accordance with Section 235100, where not factory installed.
   1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
   2. Do not exceed manufacturer's maximum back pressure requirements.

I. Provide grounding and bonding in accordance with Section 260526.

J. 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 prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

F. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
   3. Check for proper oil and coolant levels.

G. Prepare and start system in accordance with manufacturer's instructions.

H. Perform acceptance test in accordance with NFPA 110.

I. Inspection and testing to include, at a minimum:
   1. Verify compliance with starting and load acceptance requirements.
   2. Verify voltage and frequency; make required adjustments as necessary.
   3. Verify phase sequence.
   4. Verify control system operation, including safety shutdowns.
   5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).

J. Provide field emissions testing where necessary for certification.

K. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

L. 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. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

E. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.06 PROTECTION

A. Protect installed engine generator system 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 engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a 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.

E. Maintain an on-site log 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.

END OF SECTION 263213

SECTION 263623.13
AUTOMATIC/NONAUTOMATIC TRANSFER SWITCHES - SCHNEIDER ELECTRIC ASCO 7000

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-voltage automatic/nonautomatic transfer switches.

1.02 RELATED REQUIREMENTS

A. Section 033000 - CAST-IN-PLACE CONCRETE: Concrete equipment pads.

1.03 ABBREVIATIONS AND ACRONYMS

A. ATS: Automatic transfer switch.

B. NTS: Nonautomatic transfer switch.

1.04 DEFINITIONS

A. Automatic transfer switches may also be identified as ATS, ADTS, ACTS, ATB, ADTB, ACTB, AUS, ADUS, ACUS, AUB, ADUB, or ACUB.

B. Nonautomatic transfer switches may also be identified as NTS, NDTS, NCTS, NTB, NDTB, NCTB, NUS, NDUS, NCUS, NUB, NDUB, or NCUB.

1.05 REFERENCE STANDARDS

A. IEC 60947-6-1 - Low-Voltage Switchgear and Controlgear – Part 6-1: Multiple Function Equipment – Transfer Switching Equipment; 2021.

B. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test; 2025.

C. IEC 61000-4-3 - Electromagnetic Compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test; 2020.

D. IEC 61000-4-4 - Electromagnetic Compatibility (EMC) - Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test; 2012.

E. IEC 61000-4-5 - Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test; 2014, with Amendment (2017).

F. IEC 61000-4-6 - Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields; 2013 (Corrigendum 2015).

G. IEC 61000-6-2 - Electromagnetic Compatibility (EMC) – Part 6-2: Generic Standards – Immunity Standard for Industrial Environments; 2016.

H. IEC CISPR 11 - Industrial, Scientific and Medical Equipment – Radio-Frequency Disturbance Characteristics – Limits and Methods of Measurement; 2015, with Amendments (2019).

I. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

K. NEMA IA 10042-1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2025.

L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

N. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

O. UL 891 - Switchboards; Current Edition, Including All Revisions.

P. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

Q. UL 1558 - Switchgear; Current Edition, Including All Revisions.

1.06 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 each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

E. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections.

F. Manufacturer's qualification statement.

G. Installer's qualification statement.

H. Operation and Maintenance Data: Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

I. Executed warranty.

J. Project Record Documents:
   1. Configured settings/parameters for adjustable components updated to as-installed and commissioned state, noted if different from factory default.

K. 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 transfer switch components.

1.07 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, 365 days per year from manufacturer or their representative.
   4. Maintain records of each switch, by serial number, for minimum of 20 years.

1.08 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 damage or violation of delivery, storage, and handling requirements to Engineer.

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 for 24 months from date of shipment. Complete forms in Owner's name and register with manufacturer.
   1. Except for circuit breakers in service entrance transfer switches and soft load transition switches, provide replacements for parts determined to be defective at no charge for 5 years from date of shipment.
   2. Provide replacements for main contacts determined to be defective at no charge for 10 years from date of shipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Schneider Electric; ASCO 7000 Series; www.ascopower.com/#sle.

B. Source Limitations: Provide automatic transfer switches, controllers, and accessories produced by same manufacturer as other electrical distribution equipment for project and obtained from single supplier.

2.02 LOW-VOLTAGE AUTOMATIC/NONAUTOMATIC TRANSFER SWITCHES

A. Basis of Design: Schneider Electric; ASCO 7000 Series; www.ascopower.com/#sle.

B. Description: Transfer switches consisting of inherently double-throw power transfer switch with solenoid-operated mechanism and microprocessor controller; automatic or nonautomatic operation as indicated.
   1. Automatic Transfer Switches: Transfer switches with automatically initiated transfer between sources.
   2. Nonautomatic Transfer Switches: Transfer switches with manually initiated transfer between sources.

C. Comply with NEMA IA 10042-1 and IEC 60947-6-1; list and label as complying with UL 1008 and, where applicable, UL 891 or UL 1558.

D. Transfer Switch Construction:
   1. Electrically operated, mechanically held.
   2. Provide one type of main operator for available sizes for ease of maintenance and commonality of parts.

3. Positively locked, unaffected by momentary outages, such that contact pressure is maintained at constant value and contact temperature rise is minimized for maximum reliability and operating life.
4. Main Contacts: Silver composition.
5. Designed to allow inspection of contacts from front without disassembly of operating linkages and disconnection of power conductors.
6. Stationary and Moveable Contacts: Removable and replaceable without removing power conductors and/or bus bars.
7. Switches Rated 800 A and Greater: Provide segmented, blow-on construction for high withstand and close-on capability, protected by separate arcing contacts.
8. Devices utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

E. Transition Modes:
1. Open Transition:
   a. Transfer load between power sources using 2-position, break-before-make switch.
   b. Maximum Transfer Time to Alternate Source: 100 milliseconds.
   c. Electrical Operator: Momentarily energized, single-solenoid mechanism.
   d. Mechanically interlocked to allow only two possible positions, normal or emergency.
   e. Main operators which include overcurrent disconnect devices, linear motors, or gears are not acceptable.
2. Delayed Transition:
   a. Transfer load between power sources using 2-position, break-before-make switch with user-defined interruption period in both directions.
   b. Delay: Adjustable from 0 to 6 minutes with 1-second resolution.
   c. Electrical Operator: Dual solenoid mechanism, momentarily energized.
   d. Provide both electrical and mechanical interlocks to prevent both sets of main contacts from being closed at same time.
   e. Main operators which include overcurrent disconnect devices, linear motors, or gears are not acceptable.
3. Closed Transition:
   a. Transfer load between power sources without interruption by momentarily connecting both sources of power only when both sources are present and acceptable.
   b. Source Requirements for Transfer:
      1) Voltage Differential: Maximum of 5 percent.
      2) Frequency Differential: Maximum of 0.2 Hz.
      3) Phase Angle Differential: Maximum of 5 degrees.
   c. Maximum Interconnection Time: 100 milliseconds.
      1) If both normal and emergency main contacts remain closed in excess of 100 milliseconds, after preset time delay attempt to return transfer switch to "safe" state by removing paralleled condition using the following procedure:
         (a) Open last set of contacts that closed to remove overlap condition.
         (b) Activate red "TS Locked Out" indicator light.
         (c) Lock out controller from further automatic operation until reset with "TS Locked Out" pushbutton.
      2) If main contacts still remain paralleled after procedure above, use separate independent extended parallel alarm timer to operate output relay with two form C contacts to alarm extended overlap condition and shunt trip either normal or emergency source circuit breaker.

d. Operate as open transition, break-before-make switch when power source serving load fails or becomes unacceptable.
e. Accomplish transfer with no power interruption, without altering or actively controlling standby generator.
f. Electrical Operator: Dual solenoid mechanism, momentarily energized.
g. Main operators which include overcurrent disconnect devices, linear motors, or gears are not acceptable.

F. Withstand and Closing Ratings:
1. Rate to close on and withstand available RMS symmetrical short circuit current at terminals with overcurrent protection indicated.
2. Label with UL 1008, 0.025- or 0.050-second, time-based ratings, or appropriate short-time rating(s) as applicable. Transfer switches which have only series or specific-breaker ratings are not acceptable.
3. Include 0.3-second, 18-cycle, short-time rating as standard for switch sizes 600 through 4,000 A for selective coordination purposes.

G. Neutral Configurations:
1. Solid Neutral: Provide neutral conductor plate with fully rated AL-CU pressure connectors.
2. Switched Neutral: Provide fully-rated switched (break-before-make) neutral transfer contacts.
3. Overlapping Neutral:
a. Provide fully rated overlapping neutral transfer contacts.
b. Connect neutrals of normal and emergency power sources together only during transfer and retransfer operation; maintain connection until power source contacts close on source to which transfer is being made.
c. Maximum Neutral Overlapping Time: 100 milliseconds.

H. Enclosures:
1. Comply with UL 50.
2. UL 50E Rating, Unless Otherwise Indicated:
a. Indoor Clean, Dry Locations: Type 1 or Type 12.
b. Outdoor Locations: Type 3R or Type 4.

I. Pilot Devices:
1. Provide 0.63 inch, industrial-grade, door-mounted switches and pilot lights to facilitate viewing and replacement.
2. Provide separate removable plate for door controls, supplied loose for open type units.
3. Provide three-position momentary switch for test/automatic/reset modes.
a. Test Position: Simulates normal source failure.
b. Reset Position: Bypass time delays on either transfer to emergency or retransfer to normal.
4. Provide 0.63 inch, industrial-grade, type 12 LED indicating lights, consisting of one green LED to indicate when transfer switch is connected to normal source and one red LED to indicate when transfer switch is connected to emergency source.
5. Provide 0.63 inch, industrial-grade, type 12 LED indicating lights, energized by controller outputs to indicate true source availability of normal/emergency sources as determined by voltage sensing trip/reset settings for each source.

J. Controller:
1. Construction:
a. Provide single, built-in microprocessor for controller's sensing and logic for maximum reliability and minimum maintenance.
b. Provide capability for serial communication through separate module.

c. Provide single controller with 12 selectable nominal voltages for maximum application flexibility and minimal spare part requirements.
d. Connect controller to transfer switch with interconnecting wiring harness, including keyed disconnect plug to enable controller disconnection from transfer switch for routine maintenance.
e. Provide multi-layer printed circuit boards for sensing and control logic.
f. Provide industrial-grade, plug-in interfacing relays with dust covers.
g. Provide enclosure with protective cover mounted separately from transfer switch unit for safety and ease of maintenance. Include built-in pocket for storage of operator's manuals.
h. Wire customer connections to common terminal block to simplify field-wiring connections.

2. Voltage Sensing: True RMS, accurate to within plus/minus 1 percent of nominal voltage.
3. Frequency Sensing: Accurate to within plus/minus 0.2 percent.
4. Service Conditions:
   a. Ambient Operating Temperature: Between minus 4 degrees F and 140 degrees F.
   b. Ambient Storage Temperature: Between minus 67 degrees F and 185 degrees F.
5. Electromagnetic Compatibility (EMC):
   a. IEC CISPR 11, Group 1, Class A.
   b. IEC 61000-4-2.
   c. IEC 61000-4-3.
   d. IEC 61000-4-4.
   e. IEC 61000-4-5.
   f. IEC 61000-4-6.
   g. IEC 61000-6-2.
6. Controller Display/Keypad:
   a. Provide integral four-line, 20-character LCD display and keypad for viewing available data and setting operational parameters.
   b. Make operational parameters available for viewing and limited control through serial communications input port.
   c. Make the following operational parameters adjustable only via controller DIP switches:
      1) Nominal line voltage and frequency.
      2) Single or three phase sensing.
      3) Operating parameter protection.
      4) Transfer operating mode configuration (open, closed, or delayed transition).
   d. Controller Instructions and Settings: Accessible, readable, and accomplished without use of codes, calculations, or instruction manuals.
7. Provide the following integral features, capable of being activated through keypad programming:
   a. Commit to Transfer: Selectable to determine whether load should be transferred to emergency generator if normal source restores before generator is ready to accept load.
   b. Engine Exerciser:
      1) Enables user to program up to seven different exercise routines.
      2) Programmable Routine Parameters:
         (a) Enable/disable routine.
         (b) Enable/disable transfer of load during routine.
         (c) Start Time: By time of day, day of week, and week of month (first, second, third, fourth, alternate, or every week).

(d) Duration of run.
3) At end of specified duration, transfer load back to normal source and run generator for specified cool down period.

c. Provide terminals for remote contact which close to signal transfer to emergency source. If emergency source fails while connected to emergency source, but normal source is acceptable, override transfer command and return to normal source.

d. System Status: Provide system status screen for controller LCD display, accessible from menu by pressing “ESC” key maximum of two times. Display clear description of active operating sequence and switch position, such as 'Normal Failed; Load on Normal; TD Normal to Emergency; 2 min 15 s'.

e. Self-Diagnostics: Provide diagnostics screen for detecting system errors. Provide information on status input signals to controller, which may prevent load transfer commands from being completed.

f. Data Logging: Log data, storing previous 99 events in nonvolatile memory, retained in event of total power loss; include the following:
1) Event Logging:
(a) Data, time, and reason for transfer from normal to emergency.
(b) Data, time, and reason for transfer from emergency to normal.
(c) Data, time, and reason for engine start.
(d) Data and time engine stopped.
(e) Data and time emergency source available.
(f) Data and time emergency source not available.
2) Statistical Data:
(a) Total number of transfers.
(b) Total number of transfers due to source failure.
(c) Total number of days controller has been energized.
(d) Total number of hours both normal and emergency sources have been available.

K. Voltage, Frequency, and Phase Rotation Sensing:
1. Voltage and Frequency Sensing: Continuously monitored on normal and emergency sources with the following minimum pickup and dropout/trip capabilities:
a. Undervoltage:
1) Sources: Normal and emergency, 3 phase.
2) Dropout/Trip: 70 to 98 percent.
3) Pickup/Reset: 85 to 100 percent.
b. Overvoltage:
1) Sources: Normal and emergency, 3 phase.
2) Dropout/Trip: 102 to 115 percent.
3) Pickup/Reset: 2 percent below trip.
c. Under Frequency:
1) Sources: Normal and emergency.
2) Dropout/Trip: 85 to 98 percent.
3) Pickup/Reset: 90 to 100 percent.
d. Over Frequency:
1) Sources: Normal and emergency.
2) Dropout/Trip: 102 to 110 percent.
3) Pickup/Reset: 2 percent below trip.
e. Voltage Unbalance:
1) Sources: Normal and emergency.

2) Dropout/Trip: 5 to 20 percent.
3) Pickup/Reset: 1 percent below dropout.

2. Repetitive Accuracy of Settings: Within plus/minus 0.5 percent over operating temperature range of minus 4 degrees F to 140 degrees F.
3. Voltage and Frequency Settings: Field adjustable in 1-percent increments locally via display/keypad or remotely via serial communications port access.
4. When activated by keypad or through serial port, capable of sensing phase rotation of both normal and emergency sources and rejecting source if phase rotation does not match rotation reference selected in settings (ABC or CBA).
5. Source Status Screens: For normal and emergency sources, display digital readout of voltage on each phase, frequency, and phase rotation.
6. Include selectable algorithm to:
   a. Prevent repeated transfer cycling to source which experiences primary-side, single-phase failures on grounded-wye-to-grounded-wye transformer then regenerates voltage when unloaded.
   b. Inhibit retransfer to normal/utility source upon detection of single-phasing condition until dedicated timer expires, alternate source fails, or normal source fails and is restored during time delay period; time delays adjustable via display/keypad.

L. Time Delays:
1. Provide adjustable time delay of 0 to 6 seconds for override of momentary normal source outages and delay of transfer and engine starting signals. Provide capability to extend time delay to 60 minutes by providing external 24 VDC power supply.
2. Provide time delay on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of load transfer to emergency source.
3. Delayed Transition:
   a. Provide adjustable time delay of 0 to 6 seconds to override momentary emergency source outage to delay retransfer signals during initial loading of engine generator set.
   b. Provide adjustable time delay of 0 to 5 minutes for load disconnect position for delayed transition operation.
   c. Time Delays: Adjustable via display/keypad; value displayed on LCD or remote device to represent remaining time until next event occurs.
4. Closed Transition:
   a. Provide adjustable time delay of 1 to 5 minutes on failure to synchronize normal and emergency sources prior to transfer.
   b. Provide adjustable time delay of 0.1 to 1 second on extended parallel condition of both power sources during transfer.
5. Provide two time delay modes on retransfer to normal source, independently adjustable from 0 to 60 minutes; one for normal source power failures and one for test mode function. Automatically bypass time delay if emergency source fails and normal source is acceptable.
6. Provide time delay on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
7. Provide time-delay-activated output signal to drive external relay(s) for selective load disconnect control; capable of activating adjustable time delay of 0 to 5 minutes in following modes:
   a. Prior to transfer only.
   b. Prior to and after transfer.
   c. Normal to emergency only.
   d. Emergency to normal only.

e. Normal to emergency and emergency to normal.
f. All transfer conditions or only when both sources are available.

8. Time Delays: Adjustable in 1 second increments, except extended parallel time to be adjustable in 0.01 second increments.

M. Provide SPDT contact, rated 5 A at 30 VDC, for low-voltage engine start signal; prevents dry cranking of engine by requiring generator set to reach proper output and run for duration of cool-down setting, regardless of whether normal source restores before load is transferred.

N. Provide auxiliary contacts, rated 10 A at 250 VAC, consisting of one contact which is closed when transfer switch is connected to normal source and one contact which is closed when transfer switch is connected to emergency source.

2.03 SOURCE QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements for additional requirements.

B. Factory test for proper operation of individual components and compliance with sequence of operation. Verify operating transfer time, voltage, frequency, and time delay settings.

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.

C. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install equipment in accordance with manufacturer’s written instructions.

B. Install transfer switches in accordance with NECA 1.

C. Unless otherwise indicated, install and anchor floor-mounted transfer switches on raised concrete pad 4 inches high; see Section 033000.

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.
3. Identify transfer switches with label indicating inspection/testing agency and date of service.

C. Correct deficiencies and replace damaged or defective transfer switches or associated components.

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: Demonstrate proper operation of transfer switches and associated systems to Owner's designated representative and Engineer, observing and documenting compliance with Contract Documents.

D. Training:

1. Train Owner's personnel on operation and maintenance of system.
   a. Accommodate minimum of four attendees.
   b. Provide not less than one session(s) with four hours of classroom and hands-on training.
   c. Training Reference: Use submitted operations and maintenance manuals.
   d. Instructor: Factory-trained manufacturer's representative.
   e. Location: Project site.
2. Provide sufficient time and detail in each session to cover the following at minimum:
   a. Operation theory.
   b. Major equipment components.
   c. Equipment operation.
   d. Equipment configurations.
   e. Maintenance, troubleshooting, and repair.
   f. Component-level parts replacement.

3.05 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

END OF SECTION 263623.13

SECTION 264300
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

B. Surge protective devices for distribution locations.

1.02 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 262413 - Switchboards.

C. Section 262416 - Panelboards.

D. Section 262726 - Wiring Devices - Lutron: Receptacles with integral surge protection.

E. Section 271000 - Structured Cabling: Protectors for communications service entrance.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

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 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.05 SUBMITTALS

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

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
   1. UL 1449.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

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's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices:
   1. ABB/GE: www.electrification.us.abb.com/#sle.
   2. Current Technology; a brand of Thomas & Betts Power Solutions: www.tnbpowersolutions.com/#sle.
   3. Schneider Electric; Square D Brand Surgelogic Products: www.surgelogic.com/#sle.
   4. Surge Suppression, LLC (SSI): www.surgesuppression.com/#sle.

B. Factory-installed, Internally Mounted Surge Protective Devices:
   1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

D. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mouonted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:

1. Wye Systems: L-N, L-G, N-G, L-L.
2. Delta Systems: L-G, L-L.
3. High Leg Delta Systems: L-N, L-G, N-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):
1. Equivalent to basis of design.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
1. Indoor clean, dry locations: Type 1.
2. Outdoor locations: Type 3R.

H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
1. Switchboards: See Section 262413.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device - Basis of Design: Surge Suppression, LLC (SSI); Advantage Series; Model SSLB (100 kA/phase, Type 2, I-n = 20 kA); www.surgesuppression.com/#sle.
1. Voltage: As indicated on drawings.
2. Features: Discrete "all-mode" protection (10 modes for 3-phase wye circuits); component-level thermal fusing; internal circuit board-mounted overcurrent fusing; 200 kAIC SCCR; 25 year warranty.

B. Surge Protective Device - Basis of Design: Surge Suppression, LLC (SSI); SpecPRO Series; Model SSMA8 (80 kA/phase, Type 2, I-n = 10 kA); www.surgesuppression.com/#sle.
1. Voltage: As indicated on drawings.
2. Features: Seven modes of protection; component-level thermal fusing; internal circuit board-mounted overcurrent fusing; 200 kAIC SCCR; 15 year warranty.

2.04 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Surge Protective Device - Basis of Design: Surge Suppression, LLC (SSI); Advantage Series; Model SSLA (100 kA/phase, Type 2, I-n = 10 kA); www.surgesuppression.com/#sle.
1. Voltage: As indicated on drawings.
2. Features: Discrete "all-mode" protection (10 modes for 3-phase wye circuits); component-level thermal fusing; internal circuit board-mounted overcurrent fusing; 200 kAIC SCCR; 25 year warranty.

B. Surge Protective Device - Basis of Design: Surge Suppression, LLC (SSI); SpecPRO Series; Model SSMA8 (80 kA/phase, Type 2, I-n = 10 kA); www.surgesuppression.com/#sle.
1. Voltage: As indicated on drawings.
2. Features: Seven modes of protection; component-level thermal fusing; internal circuit board-mounted overcurrent fusing; 200 kAIC SCCR; 15 year warranty.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 260526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

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. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 260526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

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. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.04 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 264300

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; 2019.

C. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

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.

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. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 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.

2.04 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.

2.05 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.

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.

J. Install accessories furnished with each luminaire.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.

L. 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.

M. 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.

N. 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.

O. Identify luminaires connected to emergency power system in accordance with Section 260553.

P. Install lamps in each luminaire.

Q. 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 265100

SECTION 265600
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.

B. Ballasts.

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 (Reaffirmed 2025).

B. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2019.

C. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

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. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 1598 - Luminaires; Current Edition, Including All Revisions.

I. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. 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. 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.

I. 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.

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. Install accessories furnished with each luminaire.

I. Bond products and metal accessories to branch circuit equipment grounding conductor.

J. 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.

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 265600

SECTION 270536
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal cable tray systems:
   1. Metal ladder cable tray.

1.02 RELATED REQUIREMENTS

A. Section 270529 - Hangers and Supports for Communications Systems.

B. Section 271000 - Structured Cabling: General structured cabling system requirements.

1.03 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

B. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition; 2022.

C. NEMA BI 50015 - Metal Cable Tray Systems; 2024.

D. NEMA BI-50016 - Cable Tray Installation Guidelines; 2024.

E. 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 arrangement of cable tray with structural members, ductwork, piping, equipment and other potential conflicts. Coordinate work to avoid installation of obstructions within cable tray required clearances.
   2. Coordinate arrangement of cable tray with dimensions and clearance requirements of actual products to be installed.
   3. Coordinate work with placement of supports and anchors required for mounting.
   4. Notify of 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 affected installers. Review proposed routing, sequence of installation, and protection requirements for installed cable tray.

C. Sequencing:
   1. Do not begin installation of cables until installation of associated cable tray run is complete.

1.05 SUBMITTALS

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

B. See Section 271000 for additional submittal requirements.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable tray system components and accessories. Include dimensions, materials, fabrication details, finishes, and span/load ratings.
   1. Fiberglass Cable Tray Systems: Include requirements for strength derating according to ambient temperature.

D. Shop Drawings: Include dimensioned plan views and sections indicating proposed cable tray routing, required clearances, and locations and details of supports, fittings, building element penetrations, and equipment connections.

E. Derating Calculations for Fiberglass Cable Tray Systems: Indicate span/load ratings adjusted for applicable service conditions.

1.06 QUALITY ASSURANCE

A. See Section 271000 for additional quality assurance requirements.

B. Comply with NFPA 70.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

D. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as Nationally Recognized Testing Laboratories (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 and NEMA BI-50016, except do not store cable tray outdoors without cover as permitted in NEMA BI-50016.

B. Handle products carefully to avoid damage to finish.

PART 2 PRODUCTS

2.01 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

A. Provide new cable tray system consisting of required components, fittings, supports, and accessories, as necessary for complete system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.

D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under service conditions at installed location.

E. Unless otherwise indicated, specified span/load ratings are based on safety factor of 1.5 and working load only (i.e., no additional concentrated static load), with ratings for metal cable tray systems in accordance with NEMA BI 50015.

F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values, with values for metal cable tray systems in accordance with NEMA BI 50015 including applicable allowable tolerances.

2.02 METAL CABLE TRAY SYSTEMS

A. Manufacturers:
   1. ABB, Inc: www.new.abb.com/#sle.
   2. Cablofil, a brand of Legrand North America, Inc: www.legrand.us/cablofil/#sle.
   3. Cope, a brand of Atkore International Inc: www.copecabletray.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Comply with NEMA BI 50015.

C. Material/Finishes:
   1. Mill-Galvanized Before Fabrication (Pre-Galvanized) Steel: Comply with ASTM A653/A653M, G90 coating.

D. Metal Ladder Cable Tray:
   1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
   2. Side Rail Construction: I-beam, C-channel flange out, or C-channel flange in.
   3. Load/Fill Depth: As indicated on drawings.
   4. Span/Load Rating: As indicated on drawings.

5. Rung Spacing: 9 inches on center for straight lengths.
6. Inside Width: As indicated on drawings.
7. Inside Radius of Fittings: 12 inches.
8. Covers: Solid flat flanged.

2.03 ACCESSORIES

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage cable tray system has been completed.

B. Verify field measurements.

C. Verify dimensions and span/load ratings of cable tray system components.

D. Verify that mounting surfaces are ready to receive cable tray and associated supports.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Modifications to Existing Cable Tray Systems: Remove inactive or abandoned cables from existing cable tray system.

3.03 INSTALLATION

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

B. Install cable tray system in accordance with the following. Where requirements differ, comply with most stringent.

C. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.

D. Arrange cable tray to provide required clearances and maintain cable access.
   1. Maintain minimum clearance of 3 inches between bottom of cable tray and top of suspended ceilings, unless otherwise indicated or required by authorities having jurisdiction.

E. Install cable tray plumb and level, with sections aligned and with horizontal runs at specified elevation.

F. Cable Tray Movement Provisions:
   1. Provide expansion fittings where cable tray is subject to movement, including but not limited to:
      a. Where cable tray crosses structural joints intended for expansion.
      b. Long straight cable tray runs in accordance with NEMA BI-50016.
   2. Use expansion guides in lieu of hold-down clamps where prescribed in NEMA BI-50016.
   3. Set gaps for expansion fittings in accordance with NEMA BI-50016.

G. Cable Provisions:
   1. Use fixed barrier strips to maintain separation of cables as indicated and as required by NFPA 70.
   2. Use drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.
   3. Use cable support fittings for long vertical cable tray runs with heavy cables.

H. Provide end closures at unconnected ends of cable tray runs.

I. Cable Tray Support:
   1. Use manufacturer's recommended hangers and supports, located in accordance with NEMA BI-50016, BICSI ITSIMM, and manufacturer's requirements, but not exceeding specified span unless otherwise approved by Engineer. Provide required support and attachment where not furnished by cable tray manufacturer.

2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

J. Grounding and Bonding Requirements:
   1. Install cable tray grounding in accordance with the following. Where requirements differ, comply with the most stringent.
   2. Metal Cable Tray Systems: Use suitable bonding jumpers or classified cable tray connectors to provide electrical continuity. Do not use classified cable tray connectors where cable tray sections have been modified, such as being bent, cut, or reshaped.
   3. Provide suitable bonding conductor in each metal cable tray. Do not use cable tray as sole bonding conductor.
      a. Bonding Conductor for Galvanized Steel Cable Tray: Use bare or insulated copper conductor.
      b. Bonding Conductor for Aluminum Cable Tray: Use insulated copper conductor only; do not use bare copper conductor.

K. Cable Installation:
   1. Install cables in accordance with the following. Where requirements differ, comply with most stringent.
   2. Use appropriate cable pulling tools, applied to prevent excessive force on cable tray system and maintain minimum cable bending radius.
   3. Use cable clamps or cable ties to fasten conductors/cables to vertical and horizontal runs of cable tray.
      a. Distance Between Fastening Points for Vertical Runs: 18 inches.
      b. Distance Between Fastening Points for Horizontal Runs: As required to maintain spacing and confine conductor/cable within cable fill area.

L. Penetrations: Install firestopping to preserve fire resistance rating of building elements.

M. Identification Requirements:

N. Install cable tray covers where indicated and as follows:

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements for additional requirements.

B. Inspect cable tray system 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 cable tray system components.

3.05 ADJUSTING

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

3.06 CLEANING

A. Remove dirt and debris from cable tray.

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

3.07 PROTECTION

A. Protect cable tray system from subsequent construction operations.

END OF SECTION 270536

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 Fiber 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-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.

H. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2020.

I. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2018d, with Addenda (2020).

J. TIA-568.3 - Optical Fiber Cabling and Components Standard; 2022e.

K. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

L. TIA-598 - Optical Fiber Cable Color Coding; 2014d, with Addendum (2018).

M. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.

N. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d, with Addendum (2021).

O. UL 444 - Communications Cables; Current Edition, Including All Revisions.

P. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

Q. UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.

R. 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. Cable Trays: As specified in Section 260536.

C. 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 Station: Blue.
   6. Cable Jacket Color - Wireless WAP: Green
   7. Cable Jacket Color - Security Cameras, access control: Yellow.
   8. Cable Jacket Color - IP Clock/Speaker and speaker only: Purple
   9. 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. Product(s):
      a. CommScope; SYSTIMAX RJ45 Jacks; MGS600 Series Category 6A U/UTP Modular Jacks: www.commscope.com/#sle.
      b. 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; SYSTIMAX Category 6A U/UTP Patch Cords: www.commscope.com/#sle.

b. 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, 50/125 um (OM2) complying with TIA-492AAAB.
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. Multimode Fiber (OM1/OM2): Orange.
   b. Single-Mode Fiber (OS1/OS2): Yellow.
6. Product(s):
   a. CommScope Fiber Optic Cables; TeraSpeed Zero Water Peak Single-Mode 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; TeraSpeed 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, 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.

3. Product(s):
a. CommScope; SYSTIMAX Copper Panels; 360-IPR-1100-XX Series Patch Panels: www.commscope.com/#sle.
b. 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; SYSTIMAX Fiber Panels; HD Series Patch Panels: www.commscope.com/#sle.
b. 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. Roof mounted (2) fans, capacity 200cfm.
4. Cabinets: Steel construction with corrosion resistant finish.
5. Locks: Keyed alike.

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.

C. Wall Plates:
1. Comply with system design standards and UL 514C.
2. Accepts modular jacks/inserts.
3. Capacity:
a. Data or Combination Voice/Data Outlets: 2 ports or as indicated on drawings.
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.
      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. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.

F. 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. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.

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 271000

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SECTION 271100
COMMUNICATIONS EQUIPMENT ROOM FITTINGS - SCHNEIDER ELECTRIC APC

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 27 0526 - Grounding and Bonding for Communications Systems.

C. Section 271000 - Structured Cabling.

D. Section 281000 - Access Control System.

E. Section 282000 - Video Surveillance System.

1.02 ABBREVIATIONS AND ACRONYMS

A. IP: Internet protocol.

B. IT: Information technology.

C. LCD: Liquid critical display.

D. LED: Light-emitting diode.

E. PDU: Power distribution unit; rack-mounted.

F. REACH: Registration, evaluation, authorisation, and restrition of chemicals.

G. RoHS: Restriction of hazardous substances.

H. RFID: Radio frequency identification.

I. UPS: Uninterruptible power supply; rack-mounted.

1.03 REFERENCE STANDARDS

A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; 2005e.

B. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

C. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015, with Amendment (2024).

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d, with Addendum (2021).

G. UL 891 - Switchboards; 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 work to avoid placement of other utilities or obstructions within spaces dedicated for communications equipment.
   3. Coordinate arrangement of communications equipment with dimensions and clearance requirements of actual equipment to be installed.
   4. 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. 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:
   1. Provide technical specifications or equipment brochures. Indicate installed features and accessories.
   2. Include system operating diagram.

E. System bill of materials.

F. Design Data: Standby battery/UPS calculations.

G. Maintenance contract.

H. Field Quality Control Test Reports: Document test results, including assumptions, conditions, allowances, and corrections made.

I. Operation and Maintenance Data: Manufacturer's operation manual with startup and operating instructions.

J. Executed warranty.

1.06 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 experienced in design, manufacturing products of type specified, and testing of UPS systems for minimum of 20 years.
   2. Certified for compliance with ISO 9001 and ISO 14001.
   3. Provide environmental product declaration, per UPS.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Package products to prevent penetration by debris and allow safe delivery by ground/air transportation. Inspect products at factory for damage prior to shipping.

B. 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.

C. Store materials in their original, undamaged packages and containers, in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.

D. Equipment Containing Batteries: Do not exceed three months of storage without powering for eight hours to recharge batteries.

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 for duration below. Complete forms in Owner's name and register with manufacturer.
   1. Rack-Mounted UPS: Provide warranty from date of installation or acceptance by Owner, or 18 months from date of shipment, whichever occurs first.
      a. Rack-Mounted UPS with Lithium-ion: Five years.
   2. Provide on-site warranty extension to extend UPS warranty coverage by one year.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Schneider Electric; APC: www.se.com/#sle.

2.02 COMMUNICATIONS EQUIPMENT ROOM FITTINGS APPLICATIONS

A. Provide new communication equipment room fittings consisting of required components (e.g., equipment, conduit, boxes, connectors, hardware, supports, accessories, software, and system programming) as necessary for complete operating system that provides functional intent indicated.

B. Products: Listed, classified, and labeled as suitable for purpose intended.

C. Interface with Other Systems: Provide products compatible with other systems that require interfacing.
   1. Access control; see Section 281000.
   2. Video surveillance; see Section 282000.

D. Provide the following for technology application locations indicated on drawings:
   1. Network IP camera.
   2. Door switch sensor.
   3. Rack component monitor.
   4. IT gateway.
   5. IT expert software management access for 10 nodes.

2.03 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

A. Component Racks: EIA/ECA-310 standard 19-inch wide.

B. Cabinets: Steel construction with corrosion resistant finish.

C. Locks: Keyed alike.

D. Cover inside of cabinet back with plywood backboard as specified.

E. 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.

F. Accommodate AC normal power outlet inside cabinet, per rack-mounted PDU.

G. Products:

2.04 COMMUNICATIONS RACK-MOUNTED POWER DISTRIBUTION UNITS

A. Provide switched AC rack-mounted PDUs for sensitive electronic equipment loads.

B. RoHS compliant.

C. Modular and segmented power distribution with common input power connections, used for real-time branch monitoring of electrical attributes, outlet level monitoring, for rack-mounted cord-and-plug equipment by NEMA and IEC receptacles.

D. Display and Controls: Embedded microcontroller for monitoring and management via push button LCD interface.

E. Allow user-customizable power control and active monitoring, including remote outlet level controls.

F. Locally and remotely configurable for user-selected power sequence, including delays and user-defined alarms.

G. Operating Environmental Conditions: Ambient temperature between 41 degrees F and 131 degrees F for altitudes 10,000 ft above sea level; 5 to 95 percent relative humidity, noncondensing.

H. Characteristics:
   1. See product manual for shipping dimensions and weights.
   2. Provide mounting configuration compatible with enclosure.
   3. Mounting: Tool-less pegs.
   4. Color: Black.
   5. Maximum Continuous Output Current, per Connection:
      a. NEMA 5-15 Outlets: 15 A.
      b. C13 Outlets: 15 A.
      c. C19 Outlets: 20 A.
   6. Internal Overload Protection: Branch segments of rack-mounted PDUs containing multiple outlet types protected from overload by integral UL 891 molded-case circuit breakers, as required, per bank of outlets.
   7. Remote Functionality:
      a. Outlet Management: Switched.

I. Products:
   1. Rack-mounted PDU 2G; Schneider Electric; APC Model AP9941, switched; vertical mounting; 4,992 VA, 0U, 30 A, 60 Hz, 200/208 V, 1-phase; factory connected cable length: 10-feet;NEMA L6-30P; output: twenty-one C13, three C19.

2.05 ACCESSORIES

A. Where not factory-installed, provide additional components, e.g., lenses, and mounting accessories, as necessary for complete installation.

B. Network Camera: IP; compatible with rack monitoring.

C. Door Switch Sensor: Quantity two, per rack; compatible with rack monitoring system.

D. Rack Component Monitor: Rack-mounted; compatible with required rack and accessory components.

E. IT Gateway: Compatible with subscription services for monitoring.

F. Products:
   1. Network IP security camera; Schneider Electric; APC NetBotz Model NBPD0165 camera pod 165.
   2. Door switch sensors; Schneider Electric; APC NetBotz Model NBES0303, universal for APC NetShelter SX Enclosures 12-feet tall; quantity included two per enclosure.
   3. Rack component monitor; Schneider Electric; APC NetBotz Model NBRK0750, rack monitor 750.
   4. Gateway; Schneider Electric; EcoStructure Model INNUC0119 IT gateway.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine equipment for damage including, but not limited to, structural, moisture, and mildew.

B. Examine for conditions detrimental to completion of work, including the following:

1. Verify installation space is enclosed and weatherproof.
2. Verify wet work located in or in close proximity to installation location is completed and dry.
3. Verify work above ceilings is complete.

3.02 INSTALLATION

A. Comply with Communication Service Provider requirements.

B. Communications Grounding and Bonding: Comply with TIA-607 and NFPA 70.
   1. See Section 27 0526.

C. Perform work in accordance with NECA 1, general workmanship.

D. Install equipment in accordance with manufacturer's written instructions.

E. Coordinate and install pathways and outlet boxes in accordance with project requirements.

F. Structured Cabling: See Section 271000.

G. UPS and Electrical Grounding and Bonding: See Section 260526.

H. Identification:
   1. Use labels to identify equipment.
   2. Use manufacturer-furnished label inserts to identify communications equipment room fittings with unique identifiers.
   3. Use identification nameplates to identify cross-connection equipment, equipment cabinets, racks, frames, and enclosures as indicated on drawings.

3.03 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. Manufacturer Startup Services:
   1. Include necessary material, equipment, labor, and technical supervision.
   2. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.
   3. Services:
      a. Schneider Electric startup; WINSTL-MDC-02 assembly, UPS startup, and integration for one Level 2 Micro DC.

D. Identify equipment room fittings with label indicating inspection/testing agency and date of service.

E. Operational Readiness:
   1. Inspect and test equipment and associated systems for conformance to Contract Documents, including equipment manufacturer's recommendations, and readiness for operation.
      a. Visual Inspection:
         1) Inspect equipment for signs of damage.
         2) Verify installation per manufacturer's instructions.
         3) Inspect cabinets for foreign objects.
         4) Inspect batteries.
         5) Measure board voltages.
         6) Inspect patch cords for complete labels.
      b. Mechanical Inspection:
         1) Inspect external battery cabinet internal power wiring connections.
         2) Inspect terminal screws, nuts, and spade lugs for tightness.

c. Electrical Inspection:
   1) Verify correct input and bypass voltage; or outlet configurations.
   2) Verify correct phase rotation of mains connections.
   3) Verify correct control wiring and terminations.
   4) Verify voltage of batteries.
   5) Verify neutral and ground conductor terminations.
d. Final Testing:
   1) Verify system startup.
   2) Verify firmware control functions.
   3) Verify firmware bypass operation.
   4) Verify maintenance bypass switch operation.
   5) Verify system setpoints.
   6) Verify inverter operation and regulation circuits.
   7) Simulate UPS input power failure.
   8) Verify charger operation.
e. Correct deficiencies and replace damaged or defective equipment or associated components.

3.04 CLOSEOUT ACTIVITIES

A. See Section 017900 - Demonstration and Training for additional requirements.

B. Training:
   1. Include, as part of manufacturer startup services, services of manufacturer-authorized service representative to train Owner's personnel on operation and maintenance of system.
      a. Review procedures and schedules related to start up and shutdown, LED indicators, bypass, AC disconnect, alarm information, troubleshooting, servicing, and preventive maintenance.
      b. Review data in operation manual.

3.05 MAINTENANCE

A. Network Service Plan:
   1. Provide to Owner, proposal as alternate to base bid, separate maintenance contract for service and maintenance of system for one year from date of Substantial Completion, to include work described below; include complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with detailed schedule.
   2. Services:
      a. Network service plan; Schneider Electric; WMD1YOSNBD-MDC-02A one year coverage with monitoring and dispatch for MDC Level 2A; SmartConnect or NMC required.

3.06 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION 271100

SECTION 271123.21
COMMUNICATIONS CABLE MANAGEMENT - VELCRO BRAND ONE-WRAP

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cable management fasteners.

1.02 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

C. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.

D. UL 62275 - Cable Management Systems - Cable Ties for Electrical Installations; Current Edition, Including All Revisions.

1.03 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable management fasteners.
   1. Indicate compliance with specified reference standards.
   2. Include peel and shear strength ratings.
   3. Include available widths and colors; identify project-specific configurations.

1.04 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for packaging waste requirements.

B. Deliver materials in manufacturer’s original, unopened, and undamaged packaging.

C. Store materials at temperature and humidity conditions recommended by manufacturer to protect from exposure to harmful weather conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Velcro USA, Inc; VELCRO Brand ONE-WRAP Fasteners: www.velcro.com/#sle.

2.02 CABLE MANAGEMENT FASTENERS

A. Description: Adjustable, reusable cable management fasteners with self-engaging closure system.

B. Plenum Applications:
   1. Construction: Single-component, self-engaging fastener with polypropylene hook on one side and nylon loop backing.
   2. Fire retardant, with UL 94 V-2 Flame Rating.
   3. Plenum Rating:
      a. Listed as plenum rated in accordance with UL 62275 and CSA C22.2 No. 62275.
      b. Low smoke and heat release characteristics determined in accordance with UL 2043.
      c. Suitable for use in air handling spaces in accordance with NFPA 70 (NEC) 300.25 (B) and (C).
   4. Color, Unless Otherwise Indicated: VELCRO Cranberry (502).

5. Width, Unless Otherwise Indicated: 1/2 inch.
6. Products:
   a. VELCRO Brand ONE-WRAP 889 Fastener.

C. General Use Applications:
1. Construction: Single-component, self-engaging fastener with polyethylene extruded hook on one side and nylon loop backing.
2. Color, Unless Otherwise Indicated: VELCRO Black (330).
3. Width, Unless Otherwise Indicated: 1/2 inch.
4. Products:
   a. VELCRO Brand ONE-WRAP 888 Fastener.

D. Performance Characteristics:
1. Peel Strength: 0.66 lbf/inch, average.
2. Shear Strength: 27.9 psi, average.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify ratings and configurations of cable management fasteners.

B. Verify bundled cable groupings.

3.02 INSTALLATION

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

B. Do not install cable management fasteners outdoors or where exposed to UV light or water/moisture.

C. Spaces Used for Environmental Air: Use only cable management fasteners specified for plenum applications.

END OF SECTION 271123.21

SECTION 27 41 00
PERFORMANCE AUDIO VIDEO SYSTEMS

1.1 GENERAL

1.2 GENERAL CONDITIONS

A. For the sake of brevity these specifications shall omit phrases such as "(Sub)Contractor shall furnish and install", "unless otherwise indicated or specified", etc., but these phrases are nevertheless implied. Mention of materials and operations requires the (Sub) Contractor to furnish and install such materials and perform such operations complete to the satisfaction of the Systems Designer. Exceptions are noted herein or shown on the drawings.

B. No representative of the Owner shall have power to waive the obligations of this Contract for the furnishing of good materials or of performing good work, as herein described, in full accordance with the Contract Documents. The failure of any representative of the Owner to condemn any defective work or materials shall not release the obligation to at once tear out, remove, and properly replace the same at any time prior to final acceptance and upon discovery of said defective work or material. However, when requested, the Owner's representative shall observe and accept or reject any material furnished; and in the event the material has been once accepted by the Owner's representative, such acceptance shall be binding on the Owner unless it can be clearly shown that such material does not meet the specifications for this work.

C. Definitions of terms in this specification section are as follows:
   1. “Owner” or “End User” is Ossining Union Free School District.
   2. “Architect” is the architect of record for this project, CPL.
   3. “Systems Designer” is the designer of the systems in this specification section, Schuler Shook.
   4. “Electrical Engineer” is the engineer and designer of the associated electrical systems, CPL.
   5. “General Contractor” or “Contractor” is the Construction Manager or General Contractor, or other entity contractually responsible for the construction of the project and the full and proper completion of this specification section.
   6. “Systems Contractor” is the Sub-Contractor, responsible to the General Contractor, who is responsible for performing the scope of work described in this specification section, and in the related contract drawings (see 1.2.B).
   7. “Systems” are the audio, video, control, and network systems described in this specification section and in the related contract drawings (see 1.2.B).

D. The written specification, including all appendices, and the large format audio video drawings are collectively referred to as the contract documents. System components and criteria may be indicated in one location, or possibly in several locations in the contract documents. It is the Contractor’s responsibility to obtain clarification from the Systems Designer, prior to submitting bid documents, if the Contractor believes that there is conflict within the documentation, or if clarification of any kind is required. If the Contractor fails to obtain said clarification(s), the Contractor agrees to abide by the interpretation of the Systems Designer, without remedy for additional compensation.

1.3 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, other General Requirement Sections, apply to work of this section.

B. All work shown on Contract Drawings AV series is provided under this section.

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C. Switches, switchboards, contactors, panel boards, transformers, conduit, wire, outlets, connectors and other electrical devices specified herein or on accompanying drawings shall conform to provisions of other sections of Division 26 of the Contract Documents unless otherwise noted. Refer to 1.11 Division of Responsibility Table for additional detailed division of scope.

1.4 SCOPE OF WORK

A. Work under this section shall include the furnishing of all labor, materials, tools, transportation services, and supervision necessary to complete the installation of the systems and other items as herein listed, all as described in these specifications, as illustrated on the drawings, and as directed by the Systems Designer. Work is comprised of, but not limited to, the following principal Systems:
   1. Performance Audio Systems
   2. Performance Video Systems
   3. Production Page and Program Audio Systems
   4. Production Video Monitoring Systems
   5. Production Communications Systems
   6. ADA Assistive Listening Systems
   7. AV Infrastructure
   8. AV Control Systems
   9. Portable AV Loose Equipment
   10. Livestream AV Systems

B. The contract documents show design intent and signal flow and are not meant to be fully detailed installation drawings. It is the responsibility of the Systems Contractor to provide fully detailed installation drawings for review and approval by the Systems Designer (see submittal requirements below). It is understood and agreed to by the Contractor that the work described in the contract documents shall be fully and properly installed and must be a complete and working system per the requirements indicated in these contract documents.

C. Consistent with the detailed information contained in this specification, it is the responsibility of the Contractor to supply complete and functional overall systems. Verify complete parts lists, the accuracy of the type numbers and the overall suitability of the equipment to provide functional systems coordinated and interfaced with related work. Provide repeaters, additional switches, and similar equipment as needed for cable length limitations. Other items that are included in the scope of work but may not be fully detailed in the contract documents include, but are not limited to, hardware, rigging devices and supplies, transformers, distribution amplifiers, signal format converters, connectors, patch cords, jumpers, network, or other device SFP modules, and other devices necessary for device interfacing, isolation, installation, or gain structure.

D. Minor items of equipment needed to meet the requirements stated above, even if not specifically mentioned herein or on the drawings, shall be provided in quality equivalent to other conditions on the project with no claim for additional payment.

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E. Furnish Shop Drawings (see details in Submittals sections below) to the Systems Designer and Architect for review. All purchase of equipment, and/or fabrication or installation work performed without fully approved shop drawings is done so at the Contractor's risk. Any at risk work as described above may be rejected and if so, all cost associated with the removal of unapproved work, and replacement with approved work is not eligible for reimbursement or additional charge. This includes Division 26 electrical systems and conduit that is required to be provided to support the work described in this section. Conduit drawings related to this scope of work are required to be submitted by the Division 26 sub-contractor, with input and coordination from the Systems Contractor and Contractor, and approved by the Systems Designer and Electrical Engineer, prior to any of the work described above being performed. Any work done prior to approval of the conduit drawings submittal is at risk and any remedial work or replacement work required by the Systems Contractor and/or Electrical Engineer to correct deficiencies in unapproved work must be performed at the Contractor's cost and is not eligible for reimbursement or additional charge.

F. Furnish and install complete Systems with all necessary apparatus and equipment, wiring, etc., required to ensure complete systems in excellent working order as specified herein and on the attached diagrams.

G. Furnish all back boxes and enclosures for audio video systems panels and control devices, to be installed by Division 26 sub-contractor. Coordinate with Division 26 sub-contractor to verify proper location, orientation, and installation conditions of all back boxes and enclosures to meet project requirements. Refer to 1.11 Division of Responsibility Table and to project documentation for details.

H. Furnish, install, and terminate all low voltage wire and cable included in this specification section. This does not include AC power system distribution and terminations, except as expressly called out in these specifications or in the audio video drawings.

I. Systems Contractor is responsible for frequency scanning and coordination of any existing audio video systems devices, or audio video systems devices provided by Owner, with any new wireless transmitters and receivers. Coordinate with Contractor and Owner as necessary accounting for local frequencies already in use by other entities, and accounting for available spectrum. Provide Owner with a complete listing of all wireless equipment referenced above, and the frequencies assigned to the devices, as well as providing a list of available open frequencies for all devices that are tunable.

J. Systems Contractor must provide Control System and Digital Signal Processing (DSP) system programming and graphical user interface designs, along with any other specialized programming requirements listed or indicated in the drawings, and/or specifications, including specification appendices. Systems Contractor will provide a full set of said programming, fully tested, installed, functioning and ready for inspection prior to Systems Commissioning and Testing. Systems Contractor will then provide a full set of changes, adjustments, and additions to address any deficiencies, or changes requested by the Systems Designer during Systems Commissioning and Testing prior to turnover to the Owner. Systems Contractor will also provide one additional full set of changes and adjustments to meet requests and notes from the Owner during the last third of the initial warranty period. All of this work is part of the base scope of work covered by these contract documents. Changes required to support additional equipment added to the systems during warranty period, that is not part of the work in these contract documents is not included in the work described above. Any such work should be proposed to the Owner with the costs for that work for the Owner to approve prior to work being performed.

K. Perform all initial systems settings and required Systems Contractor testing (see paragraphs 3.10, 3.11, and 3.12 below) and submit all required test reports, and a Declaration of Audio Video Systems Completion.

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L. Provide any required manufacturer training or commissioning (see paragraphs 3.14 below)

M. Participate, along with manufacturer's representatives (if required), in Systems Designer Commissioning, Testing, and Systems Adjustments.

N. Remedy all outstanding punch list items prior to Owner training.

O. Provide training sessions, as required in paragraph 3.14 below, to the Owner's Designated Staff.

P. Provide systems documentation, as required in paragraph 3.15 below, to the Systems Designer for review and approval.

Q. Provide systems documentation to the Owner, as required in paragraph 3.15 below, corrected per any notes from the Systems Designer.

R. Warranty all equipment, components, and workmanship per the warranty requirements in paragraph(s) 1.7 below.

S. Contract documents for work in this section includes references to supporting work to be provided by other divisions and specification sections. That work is NOT included in this scope of work and is only referenced to show related work to assist in coordination. Refer to the Division of Responsibility Table in paragraph 1.11 for detailed information on division of related labor between sub-contractors. The Contractor is ultimately responsible for completion of all this scope of work and any related supporting scopes of work.

1.5 JOB CONDITIONS

A. Verify all conditions on jobsite applicable to this work. Coordinate with scheduled work of other trades. Notify Systems Designer in writing of discrepancies, conflicts, or omissions prior to commencement of work or correct same at Contractor's expense.

B. The drawings show diagrammatically the cables, conduit, wiring, and so far as possible, the arrangement of equipment, which fit into the spaces available without interference. If conditions exist at the jobsite which make it impossible to install work as shown, prepare and submit drawings to the Systems Designer for approval showing how the work may be installed and, on approval, install the work without additional cost to the Owner.

C. Contractor and their sub-contractors shall take care not to damage any equipment or to disconnect any wiring other than as required to interface new system. Any contractor-damaged equipment shall be repaired or replaced by the Contractor at no cost to the Owner.

D. The Systems Contractor must keep the job adequately staffed at all times.

E. For no reason other than illness, loss of personnel, or other circumstances completely outside the control of the Systems Contractor, the Project Engineer, Project DSP and Control Systems Programmers, and the Lead Installer shall remain with the project from beginning through completion. In cases where a change must occur, the same pre-bid requirements for CTS-D and CTS-I certification apply to the new staff members, and in anything other than a catastrophic and immediate loss, there must be a minimum of a one week overlap between personnel on the project. The Systems Contractor MUST provide the Systems Designer, notice of any change, including a general reason for the change, and a detailed plan as to how the continuity of information will be achieved. This requirement does not apply to staff other than those directly named above.

F. The Contractor is responsible to perform all cutting, patching, and painting or other work necessary to match finish treatments during installation of the systems and to repair any damage done as a result of installation of the systems. The Contractor is responsible for all cleanup and trash removal from all systems work areas.

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G. The Systems Contractor will cooperate with the Contractor and any or all sub-contractors and the Owner, Owner's Representative, and all other appropriate parties to coordinate progress with the overall construction schedule. Watch for conflicts with work by other contractors on the job. Without claim for additional payment, make moderate moves or changes as are necessary to accommodate other equipment or to maintain aesthetic appearance.

H. The Contractor will provide and maintain fully finished, dust free and conditioned spaces for all control rooms and rack locations prior to any installation of systems racks or electronics. In addition the Contractor must provide adequate protection to installed loudspeakers, displays, projectors, cameras, and other systems equipment to protect them from damage and from dust or exposure to other contaminants, such as water or paint overspray.

1.6 SUBMITTALS

A. Pre-Bid Submittals
   1. All Systems Contractors providing bid responses for the systems specified in this section must provide the following documentation for review no later than ten (10) days prior to the bid due date, and must be deemed qualified, in writing, by the Systems Designer.
      a. A list of projects performed within the last four years of comparable size, and scope (minimum four projects). For each project provide the project name and address, dates of construction start and completion, and a name and phone number for a contact representing the Owner or User.
      b. A description of the Systems Contractor's facilities used for, and capabilities in the following areas:
         i. Shop fabrication
         ii. Rack assembly and wiring
         iii. Equipment repair
         iv. Systems servicing
         v. Creation of CAD, REVIT, or other graphics documentation for shop drawings and as-built drawings
      c. Resume listing education and experience of the staff member (or members) who will be the project engineer.
      d. Current CTS-D certificate(s) for the staff member(s) in item c. above.
      e. Resume listing education and experience of the staff member (or members) who will be the lead installer on-site. The lead installer must be present on-site at all times when installation work is being performed.
      f. Current CTS-I certificate(s) for the staff member(s) in item e. above.

B. Bid Submittals
   1. Contractors must carefully examine all drawings and specifications for this project. No allowances will be made for failure to read and understand all of the project documentation.
   2. Requests for clarification during the bid process must be submitted in writing, directed to the proper contact. Do not contact the Systems Designer directly. All requests for clarifications must be made no later than seven (7) working days prior to the bid submission date.
   3. Bid proposals must include all of the systems equipment as specified, and all work effort required to engineer and install the systems to meet the specification and drawing requirements. They must also include any other materials, equipment, and labor that may not be shown that is required to deliver a fully functioning and operable systems per the intent of the specifications and drawings.

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4. Substitutions of equipment in the design are not allowed during the bid process. The Systems Contractor may provide alternative equipment as options in their submittal, but they must provide a complete bid response based on the systems as designed, with the options shown separately (See 1.5.B.6.e below).
5. The scope of work indicated in this specification and the AV drawings must be performed by the Systems Contractor and may not be sub-contracted or assigned to others unless the following requirements are satisfied:
    a. All sub-contractors must be bound by the terms of this specification including bidding and qualification requirements and must agree to this in writing as part of the bid response package.
    b. The names of all proposed sub-contractors and a statement of their qualifications (see 1.5.A.1 in its entirety above) must be included in the bid response package.
6. All bid response packages must include the following information, in its entirety, or they will be rejected, in whole, as unresponsive:
    a. An itemized list of all equipment and materials to be used in the installation of the systems in this scope of work. This list must include a short item description, item name, and manufacturer's name, quantity of items included, and a unit price for that item. Lot prices may be used instead of unit prices only for miscellaneous items not included in the list of specified equipment. Any manufacturer quotes referenced in the equipment list in this specification section must be broken out into unit descriptions as described above.
    b. A labor breakdown as follows:
        i. Pre-installation engineering (includes shop drawings and other documentation as well as submittals)
        ii. Coordination meetings, site coordination, and supervision
        iii. Shop engineering and assembly
        iv. Shop programming time
        v. Site installation work
        vi. Site programming time
        vii. Systems Contractor verification of systems
        viii. Systems Designer commissioning and tuning
    c. Total contract price for the base project as designed
    d. Total contract price for each add alternate as designed
    e. For each of any proposed options provide the following:
        i. Itemized list of equipment from the design that will be replaced by the option with the same information required in 1.5.B.6.a above.
        ii. Lump sum labor cost attached to the list of equipment from the design that will be replaced by the option.
        iii. Itemized list of equipment that will replace the equipment listed above in item I, with the same information required in 1.5.B.6.a above.
        iv. Lump sum labor cost attached to the list of equipment from the option.
        v. Total Add or Deduct amount from the Base Bid if this option is selected.

C. Pre-Installation Submittals
1. The following guidelines must be adhered to for all submittals to be reviewed:
    a. All shop drawings must be sized such that the paper size matches that of all other project construction drawings. All drawings must be legible when printed at ½ actual size.
    b. Drawings should be done in black and white. Color may only be used to indicate specific signal types in single-line drawings, but in that case, they must still be legible with all information clearly seen if printed in black and white.

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c. Drawings and all other submittal documentation should be provided in PDF format. DWG files and Revit models must be provided upon request. All drawings shall be produced in AutoCAD or Revit or in a compatible software that can produce accurate files that are compatible with AutoCAD or Revit.
d. Submittal of contract drawings or copied portions of contract drawings as shop drawings is not allowed and they will be rejected. Use of electronic files generated by other parties (Systems Designer drawings or architectural backgrounds, for example) does not release the Systems Contractor from the responsibility to provide accurate, fully engineered, coordinated, and functional systems and complete solutions. The Contractor and Systems Contractor must provide systems that meet or exceed all contract document requirements.
e. All revised submittals must include a revision number and date. All changed drawings or documents must clearly indicate the revision number and date, and all changed items must be clouded and tagged with the revision number. All subsequent revisions must have prior revisions clouds and tags removed for clarity. Drawings or documents included in a revised submittal that have NOT changed must not be marked as revised. Revisions that are not properly tagged may not get reviewed. This does not release the Systems Contractor from the responsibility to provide all revisions as are indicated in submittal responses.
f. All submittals must reflect the project awarded, as a whole, including all Owner accepted add/deduct alternates, all Systems Designer approved, Owner accepted Systems Contractor options proposed at bid, and all Systems Designer approved, Owner accepted post-bid, pre-installation, Systems Contractor proposed substitutions.

2. Every Submittal must include, as the first sheet, a table of contents of what all is provided within that particular submittal.
3. Submittal submissions must follow the following schedule:
   a. List of Activities Submittal: Within 30 days of award the Systems Contractor must provide work effort documentation that includes:
      i. List of activities that require coordination with the Owner
      ii. List of activities that require coordination with the Architect
      iii. List of activities that require coordination with the Systems Designer
      iv. List of activities that require coordination with the Contractor and other trades.
      v. List of all key procurement items and drop-dead dates for procurement and delivery to maintain schedule.
      vi. Schedule indicating all of the items listed in items a. through e. above and indicating critical path.
      vii. All activities related to coordination listed in a. through d. above must be examined and agreed upon by all other parties prior to submittal.
   b. Substitution Request Submittal: Within 30 days of award the Systems Contractor must submit all post-bid, pre-installation period substitution requests per the following requirements:
      i. Substitutions may only be incorporated into the design upon acquiring written consent and stamped approved substitution submittal documents from the Systems Designer.
      ii. Substitution products/systems must be equivalent or better than specified products/systems in quality, performance, function, warranty, and conformance to system requirements.

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iii. After the 30 day period mentioned above, the only Systems Contractor proposed substitutions that will be reviewed for approval are those required to replace discontinued products or products that cannot be procured in time to avoid project delays.

iv. No substitution may be approved without providing the following information for review:
   a) List of any advantages to the Owner
   b) List of any disadvantages to the Owner or lost functionality, whether that functionality is required by the systems design or not.
   c) Printed specifications and/or laboratory test data for the substitution product AND the original product.
   d) Description of previous field use and successes and failures.
   e) Global cost savings reflecting total cost of equipment and labor and other costs incurred by changes in other Contractor's scope of work to support the substitution.
   f) Unit price of each proposed item, and of the item being replaced.
   g) In rare instances, the Systems Designer may request a sample of a proposed substitution for evaluation to determine acceptability as a substitute. In this situation, the Systems Contractor will procure and ship the sample to the Systems Designer, at the Systems Contractor's cost. The Systems Designer will evaluate the sample and then return it to the Systems Contractor. If the Systems Designer agrees, the sample may be provided by the manufacturer directly, at their cost, for evaluation.

v. The Systems Designer is the only party that may determine if a proposed substitution is acceptable. If the Systems Designer determines that the substitution is not acceptable, the Systems Contractor must provide the specified product from the contract documents.

vi. Where a substitute material or method is approved, the Contractor must make all changes to accommodate the substitution with no claim for additional payment beyond that included in item iv. e) above.

vii. The Systems Designer reserves the right to substitute new products for products specified in the contract documents provided there is no material cost increase to the Contractor and the Contractor has not purchased the originally specified equipment.

c. Conduit Riser Diagram Submittal: Within 45 days of award the Electrical Contractor and Systems Contractor must provide the conduit riser diagrams submittal. This submittal is the responsibility of the Electrical Contractor to create and submit, with input from the Systems Contractor. Any conduit installed prior to receiving a stamped approval of the riser submitted is at risk, and if it is found to be deficient, it must be removed and properly installed per specifications and per the approved riser, at the sole cost of the Contractor.

d. Equipment List and Product Data Submittal: Within 60 days of award the Systems Contractor must provide the following in a single PDF format document:
   i. Itemized list of all equipment and materials to be used in assembling the system.
   ii. Catalog cut sheets or data sheets for each listed item.
      a) Product data sheets must not be web page captures of specifications, unless there is no other recourse.
      b) Product data sheets with multiple options or part numbers must clearly be marked with the selection to be used for this project. All options must be called out. Anything the Contractor is not supplying that is shown on the sheet must be called out as an exclusion.

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iii. Equipment list and product data sheets shall be in the same order as the specification major equipment list in appendix B.

e. Shop Drawing Submittal: Within 60 days of award the Systems Contractor must provide the following in a single PDF format document:
   i. Plan and RCP drawings indicating the location of equipment and termination panels.
   ii. A complete list of all cabling, wire by wire. Each entry in the list must include the unique wire number for that cable, and the termination locations of each end
   iii. Detailed 3-wire schematic diagrams for any custom circuitry
   iv. Detailed 3-wire schematic diagrams for typical connections between audio lines, patch bays, and rack mounted equipment.
   v. Drawings of any custom items in a scale suitable for fabrication. The drawings must detail materials, colors, finishes, and any lettering or other markings. All lettering must be shown in the size and typeface to be used. These drawings include custom plates, rack panels, termination plates and any other custom manufactured equipment.
   vi. All custom panels in the direct view of the general public may require a custom finish. Provide a list of all panels in the direct view of the general public and their location so that the architect may respond with any custom finish requirements. The Architect may request samples of each custom finish required. The Contractor must provide these samples to the Architect upon request, for approval. Costs for the samples and shipping the samples to the Architect shall be the sole responsibility of the Contractor. Submitted samples will not be returned.
   vii. Rack elevation drawings indicating equipment locations within the rack, power distribution and any cabling routing information. Elevate the front and rear of all racks. Notate any equipment in the rack that must have a security cover, per the rack specifications below.
   viii. Patchbay layout drawings at 1:1 scale showing labeling and indicating any normal connections and the type of normal connection.
   ix. Mechanical drawings showing mounting and/or rigging of all permanently installed AV Systems equipment, including but not limited to projectors, projection screens, displays, loudspeakers, cameras, and other AV devices that mount to architecture or structure. Additionally provide drawings for any permanently installed mounting plates designed to support portable AV systems equipment. All mounting systems must be a fully engineered solution, must be approved in concept by the Systems Designer, and each drawing sheet must be stamped by a licensed structural engineer selected by the Contractor. Each custom solution must be shown separately and verified and stamped independently.

f. AV Network Submittal: Within 75 days of award the Systems Contractor must provide the following in a single PDF format document:
   i. In coordination with the Owner's IT department, provide a networking plan for the AV systems networks. This plan must include:
      a) Narrative description of the network design and function including but not limited to information describing all LAN's, VLAN's, and QOS plan.
      b) Physical network diagram
      c) Logical network diagram
      d) IP Address table and addressing protocol, including fixed IP addresses for all AV systems devices. This document must be updated for the as-built submittals to indicate the corresponding MAC address for each device.

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ii. Provide a written plan for EDID and HDCP management for all video signals and interconnection between devices.

g. User Interface GUI Submittal: Within 90 days of award the Systems Contractor must provide the following in a single PDF format document:
   i. A mockup of all graphical user interface screens for touch panels, computer displays, portable devices and any other display format, including but not limited to all loudspeaker control software, Digital Signal Processing software, Video routing and switching software, and control systems software.
   ii. Source code and configuration files for any and all devices, as required for proper systems operation.

h. Bi-weekly Progress Report Submittals: Every two weeks after award, the Systems Contractor must provide a progress report that includes:
   i. Overall status of the project and work completed by percentage
   ii. Schedule changes
   iii. Detailed Three-week work plan
   iv. Procurement updates:
      a) Procurement problems
      b) Concerns needed to be addressed by others
      c) Value of materials procured and stored on site, or if allowed, in the Systems Contractor facility as a dollar value and a percentage of total project materials cost.
   v. List of outstanding submittals indicating document number and date of submittal, in order from most recent to first submittal.
   vi. List of outstanding RFI's indicating document number and date of submittal, in order from most recent to first submittal.
   vii. Indicate any items in v. and vi. above that are overdue and whether or not they are affecting schedule. If they are affecting schedule provide information as to why and how they are affecting schedule.

i. Equipment Purchase Authorization Submittal: 30 days prior to any equipment purchase the Systems Contractor must request line-item authorization from the Systems Designer to purchase equipment. This is to avoid procurement of equipment that may already be outdated by the time of procurement. The Systems Designer shall respond to the Systems Contractor within 15 days of receipt of the procurement request with approvals and/or replacement products. There will be no allowance for schedule extension based on this requirement.

j. AV System Test Report and Written Statement of Completion Submittal: At completion of installation and Systems Contractor testing (see 3.10, 3.11, and 3.12 for testing requirements), the Systems Contractor must provide the following in a single PDF format document:
   i. Written Statement of Completion that verifies the installation is 100% complete and has been tested as required, and is ready for the Systems Designer to perform testing and commissioning of the systems.
   ii. A Testing Report that includes:
      a) ALL test data from all tests, including failed tests and subsequent passing tests after rectifying the problem that caused failure. Test data should include Flunke printouts for data and fiber tests and should show pass/fail status of every individual parameter being tested as part of the cable verification process.
      b) Usage of any spare cabling to replace cabling that was damaged during installation. Include the wire numbers of the failed cable and the spare used to replace it.

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c) A listing of any and all portable equipment, cabling, racks, etc. that is not located on site, a reason for that, and a date as to when it is expected on site.

k. AV As-Built and O&M Manual Submittal: Within 30 days of completion of Systems Designer testing and commissioning, Owner training, delivery of any missing equipment, and resolution of any and all punch items including software programming changes, the Systems Contractor must provide the following on five separate USB storage devices (three to the Owner, and two to the Systems Designer):
   i. Systems Documentation:
      a) Table of contents
      b) Written Guarantee and service policy
      c) Copies of all shop drawings which have been updated to include any changes made during the installation process.
      d) Single-line signal diagrams identifying all cable runs and patchbay points with the associated cable number
      e) Complete Systems Contractor Testing report
      f) Complete and updated conduit riser diagram to match installed conduit.
      g) Final system settings for all settings adjusted during Systems Designer testing and commissioning
      h) Updated network documentation as listed above
      i) All updated and current system software files, source code, GUI designs, and any other software files for all of the AV Systems
      j) All available manufacturers' operation and service literature for each major system and system component.
      k) Systems operational procedures including power on sequences, power off sequences, recovery from power failure sequences, emergency procedures, and any other procedures needed to operate the systems properly in any and all states.
      l) In addition to the above, provide to the Owner, two printed copies of items j) and k) above.
      m) In addition to the above, provide to the Owner one laminated copy of each sheet of each Single-Line signal diagram for each venue as per item d) above.

1.7 QUALITY ASSURANCE

A. All parts shall be provided complete per manufacturer's specifications and with all necessary accessories required to meet the intent of the design and provide fully functional systems, including but not limited to any mounting devices, software licenses, SFP modules, etc.

B. All materials shall be new and shall meet or exceed all applicable requirements and standards of Underwriters Laboratories and the American Standards Association.

C. Systems Contractor is responsible for obtaining and paying for all permits, licenses and inspections, for meeting any requirements of permits and licenses, and for remediating any work called out as incorrect or not meeting code or other standards during inspections.

D. Systems Contractor must act in accordance with applicable federal, state, local, and union labor regulations.

E. Installation shall conform to latest federal, state and local electrical and safety codes or those of other authorities having jurisdiction (AHJ). Where conflicts exist, the most stringent code or regulation shall apply.

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F. If additional work by the Systems Designer is required as a direct result of deviations from approved drawings and specifications during construction, the Contractor will be liable for those additional costs that the Owner may incur.

G. Government Standards: The Systems Contractor is to comply with all government regulations, standards, and laws that apply to the installation and use of the AV equipment and/or other scope of work specified in this section. The following agencies have laws and rules that apply:
   1. Federal Communications Commission (FCC): FCC rules are located in Title 47 of the Code of Federal Regulations. The following is a partial list of the FCC regulations that apply to equipment specified in this section of work:
      a. Part 15: Radio frequency devices
      b. Part 22: Public mobile services.
      c. Part 24: Personal communications services.
      d. Part 25: Satellite communications.
      e. Part 27: Wireless communications service.
      f. Part 51: Interconnection.
      g. Part 74: Experimental radio, special broadcast, and other program distribution services.
      h. Part 95: Personal radio services.
   2. Occupational Safety and Health Administration (OSHA) – Follow all applicable standards for health and safety particularly sound pressure level exposure.
   3. ANSI Standards: American National Standards Institute (ANSI) standards cover safety, fabrication, assembly, installation, rigging, equipment handling, and testing.
   4. Contributing Organizations – The Organizations listed below have published standards used to establish the technical references to be followed under this scope of work.
      a. Acoustical Society of America (ASA) (ASC S1)
      b. Alliance for Telecommunications Industry (ATIS) (ASC T1)
      c. American Society of Safety Engineers (ASSE) (ASC A1264)
      d. Audio Engineering Society (AES) (ASC S4)
      e. Electronics Industry Alliance (EIA) (CEMA)
      f. Entertainment Services and Technology Association (ESTA) (ASC E1)
      g. Institute of Electrical and Electronics Engineers (IEEE) (ASC C136) (802.1)
      h. International Cable Engineers Association (ICEA) Formerly IPCEA
      i. International Standards Organization (ISO)
      j. National Electrical Manufacturer's Association (NEMA) (ASC C119)
      k. National Fire Protection Associations (NFPA)
      l. National Safety Council (NSC) (ASC A10)
      m. Photographic and Imaging Manufacturer's Association (PIMA)
      n. Society of Motion Picture and Television Engineers (SMPTE)
      o. Telecommunications Industry Association (TIA)
      p. Underwriters Laboratories (UL) (ASC C101) (CE)
      q. NTSC
      r. BICSI
      s. National Association of Broadcasters (NAB) – System technical standards for video and RF compliance are listed in the most recent edition of the NAB Handbook
   5. Safety Standards – Contractor will adhere to the following Safety Standards for all work identified in Division 27 41 00 and as part of the General and Supplementary sections of the Division-1 Specifications.
      a. ANSI A14.2-2000: Safety Requirements for Portable Metal Ladders
      b. ANSI A14.7-2000: Safety Requirements for Mobile Ladder Stands and Mobile Work Platforms.

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c. ANSI C2-2002: National Electrical Safety Code
d. ANSI Z136.1-2000: Safe Use of Lasers and laser systems
e. ANSI Z136.2-1997: Safe Use of Optical Fiber
f. ANSI Z359.1-1992 (R1999): Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
g. ANSI/PIMA IT7.101-1999: Recommended Practice for the Safe Handling and Operating of Audiovisual Equipment.
h. IEEE 142-1991: Grounding of Industrial and Commercial Power Systems
i. UL 514A: Scrub Water exclusion from AV Floor Boxes
j. UL 1419-1995: Standard for Safety for Professional Video and Audio Equipment
k. in accordance with the National Electrical Code, ANSI/NFPA 70
l. UL 1492-1994: Standard for Safety for Audio-Video Products and Accessories
m. UL 1651-1997: Standard for Safety for single and multiple Optical Fiber Cable
n. UL 1667-1996: Audiovisual Systems Safety Standard for Tall AV Institutional Carts for use with Audio, Video, etc.
o. ANSI E1.1-1999: Construction and Use of Wire Rope Ladders to prevent most injuries
p. ANSI A10.8-2001: Safety Requirements for Scaffolding
q. ANSI A10.42-2000: Rigging Qualifications and Responsibilities

6. Applicable Performance Standards – Execute all Division work in accordance with the following standards:
   a. ANSI S4.48-1992 (R1998): Recommended Practice for the Application of Connectors, Part 1, XLR-Type polarity, and gender
   b. ANSI S4.55-1997: Recommended Practice for conservation of the Polarity of Audio Signals
   c. ANSI S4.56-1997: Recommended Practice for the subjective evaluation of Loudspeakers
   d. ANSI S12.2-1995 (R1999): Criteria for Evaluating Room Noise
   e. ANSI T1.217-1991 (R1998): Integrated Services Digital Network (ISDN)
   f. Management –Primary Rate Physical Layer
   g. ANSI T1.522-2000: Quality of Service (QOS) for Business Multimedia Conferencing. Specifies classes of Service for conferencing on IP Networks
   h. AES15: ANSI S4.49: AES Recommended practice for Sound Reinforcement Systems –Communications Interface PA-422.
   i. AES-R1-1997 AES project report for professional audio: Specifications for audio on high-capacity media
   j. AES14-1992 (r1998) AES standard for professional audio equipment -- Application of connectors, part 1, XLR-type polarity and gender
   k. AES24-1-1999, (Revision of AES24-1-1995) AES standard for sound system control - Application protocol for controlling and monitoring audio devices via digital data networks
   l. AES26-2001 (Revision of AES26-1995) AES recommended practice for professional audio -- Conservation of the polarity of audio signals
   m. ANSI/TIA/EIA 606-1993: Standard for the Telecommunications Infrastructure of Commercial Buildings
   n. ANSI/TIA/EIA 607-1994: Commercial Building Grounding and Bonding Requirements for Telecommunications
   o. IEEE 149-1979 (R1990): Test Procedure for Antennas
   p. IEEE 1100-1999: Powering and Grounding Sensitive Electronic Equipment
   q. NEMA 250-2001: Enclosures for Electrical Equipment

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r. SMPTE 292M: SMPTE 292M defines the base 1.485Gbps HD-SDI. Note: This standard can handle all HD formats except 1920*1080 @ 50P and 60P.
s. SMPTE 372M: Uncompressed Dual-Link HD-SDI for 50P & 60P
t. SMPTE 424M: 2.97 Gbps HD-SDI for 50P & 60P
u. TIA/EIA-568-B: Digital audio over Cat5 audio cable
v. UL 1047-1999: Isolated Power Systems Equipment
w. UL 1581-1998: Reference Standard for Electrical Wires, Cables, and Flexible Cords
x. UL 1682-1998: Standard for Safety for Plugs, Receptacles, and Cable Connectors, of the Pin and Sleeve Type up to 800 Amperes and up to 600 volts ac or dc.
y. UL 467-1998: Grounding and Bonding Equipment
z. UL 813-1999: Commercial Audio Equipment and accessories for use in commercial enterprises
aa. ANSI/TIA/EIA-568-A: Commercial Building Telecommunications Cabling
bb. ANSI/TIA/EIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces
cc. ANSI/TIA/EIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
dd. ANSI/TIA/EIA TSB-72: Centralized Optical Fiber Cabling Guidelines
ee. ANSI/TIA/EIA-526-14A: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
ff. ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single mode Fiber Cable Plant
gg. ANSI/IEEE C-2 National Electrical Safety Code how to install cabling in accordance with the most recent edition of BICSI® publications:
    i. BICSI Telecommunications Distribution Methods Manual
    ii. BICSI Cabling Installation Manual

1.8 WARRANTY AND WARRANTY SERVICE REQUIREMENTS

A. All systems devices shall be guaranteed free of defects in materials and workmanship for a minimum period of one year and for a maximum period not to exceed the length of the manufacturer's warranty. All workmanship will be guaranteed free of defects for a period of one year. These warranty times begin on the date the Systems Designer accepts the systems as complete.

B. The Integrator will provide the Owner with an emergency service request phone number that will be answered 7am to 9pm, on all days the facility is open. See response times below.

C. In a non-emergency situation, defective devices shall be repaired or replaced within two business days following the report of such defects by the owner, and telephone calls must be responded to within one business day.

D. Many of the systems installed as part of this scope of work are critical to the operation of the facility. As such it is mandatory that the following replacement and response times be strictly adhered to in a Qualifying Emergency Event. Qualifying emergency events are defined as events that may cause severe hardship or cause the systems to be inoperable or unusable for a scheduled class or event. In an emergency event:
    1. The Systems Contractor must respond to telephone calls within one hour. The personnel answering this call must be fully qualified to troubleshoot problems and propose solutions.
    2. If the situation requires a site visit, The Systems Contractor must have personnel on-site within twenty four hours of the phone call determining the need.
    3. If corrective measures on-site are required, they will be performed within twenty four hours of the determination of a need for a site visit.

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E. If, during the warranty period, any component is out of service for more than seven days due to unavailability of parts or service, Contractor shall supply and install an identical new component. If an identical component is not available, Contractor will substitute equivalent equipment, with the approval of the Owner.

F. Repeated device failures, defined as the failure of a device or a single type of device three or more times over three contiguous months, will be considered as a failure of a manufactured system and all items of this type shall be replaced at no charge to the Owner.

G. During the course of the warranty period, the Contractor shall provide a minimum of three (3) service visits to the site for inspection and adjustment of equipment. Contractor shall submit proposed schedule for these visits and shall notify Owner and Systems Designer in writing at least one month in advance of each visit.

H. During the warranty period, the Systems Contractor will supply the Owner with any published updates of manufacturer provided operating software and firmware for any and all software-controlled equipment that are issued to correct “bugs”. During the warranty period, the Owner will rely on the Systems Contractor to determine when to update the software and/or firmware, unless it is needed to correct a situation that renders the systems unstable, non-functional, or otherwise affects operations.

I. At least one representative of the Systems Contractor, well versed in the installation and the operation of the systems, shall be on site in support of the Owner for the first significant public event in each venue (as determined by the Owner) where the system will be used. The Contractor representative(s) for this event shall also be competent in show operations.

J. The Contractor is to coordinate ongoing remote access to AV Systems Networks for support and troubleshooting. Owner to provide the access at their discretion.

1.9 PERMIT

A. Obtain all permits necessary for the execution of any work pertaining to the installation and conform in all trades with all applicable codes/regulations. Obtain all permits necessary for operation of any equipment by the Owner, including but not limited to laser projectors and radio systems.

1.10 INSURANCE

A. All equipment and materials shall be fully insured, by the Systems Contractor, against loss or damage up until acceptance of the system by the Owner or until Owner relieves the Contractor in writing of this responsibility, whichever is earlier, regardless of the location of the equipment. All equipment is deemed to be under the control of the Systems Contractor until acceptance of the system by the Owner or until Owner relieves the Contractor in writing of this responsibility, whichever is earlier.

1.11 EXISTING CONDITIONS

A. For projects including renovation work on existing facilities, visit the site prior to making a bid. No subsequent allowance will be made due to failure to thus observe and verify conditions which may affect the work. Report to the Architect and Systems Designer any discrepancies among this specification and existing conditions and similarly report obvious omissions.

PART 2 - EQUIPMENT

2.1 GENERAL EQUIPMENT

A. All equipment specified by manufacturer and model number is done so for the purposes of establishing a standard of quality, performance, construction and function.

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B. All materials and equipment shall be of the latest design or model offered for sale by the manufacturer.

C. All equipment will be new and be supplied with a full manufacturer's warranty.

D. The equipment provided shall operate at the required AC line voltage and frequency for the available power supply.

E. Contractor shall provide quantities as indicated in the specifications, specification appendices, and in the large format AV drawings. Where quantities appear to differ, the Contractor must request clarification from the Systems Designer.

F. Audio & Video Wire and Cable
   1. All wire numbers listed in the drawings are Windy City unless otherwise noted.
   2. THHN wire is not an allowable substitute for twisted pair stranded loudspeaker wiring.
   3. Approved manufacturers: Belden, Canare, Gepco, West Penn, Whirlwind, Windy City.
   4. Where conflict exists with any codes or ordinances, such codes and ordinances shall take precedence.
   5. Where conflict exists with electrical specifications, the higher standard or more stringent requirement shall apply, at the discretion of the Systems Designer or AHJ.

G. AV System Plates and Panels:
   1. Rack Mount Panels shall be constructed of 11-gauge steel or 1/8" Aluminum, minimum thickness. Finish shall be black or match adjacent equipment. The panels shall be 19" wide with standard EIA mounting hole spacing. Height as specified.
   2. Back Box Enclosures shall be code grade steel. Black, Galvanized, or Stainless Steel (for NEMA4 or 4X). Size as specified.
   3. Plug Box and Termination Panels shall be constructed of 11-gauge steel or 1/8" Aluminum, minimum thickness. Finish shall be black (unless instructed otherwise by Architect – see 1.5.C.3.e.iv. Size as specified. Approved Manufacturers: Steel City, Raco, Hoffman, Whirlwind, Pro Co, Wireworks
   4. Engraved lettering is white paint filled engraving on black anodized panel unless it is a custom color panel in which case, confirm lettering color with Systems Designer. Lettering is to be upper case, 14 point, Arial. Where spacing is critical, reduction to 12 point is allowed.

2.2 MAJOR EQUIPMENT

A. Equipment provided shall be that specified herein or approved substitute (see Paragraph 1.5.C.3.b).

B. Detailed performance specifications shall be those published by the manufacturer effective on the date of this document for all equipment listed.

C. See Major Equipment List in Appendix B.

2.3 DETAIL DRAWINGS

A. The drawings herein may detail custom built equipment and system details.

B. Furnish all materials and labor to provide complete and finished work even though not specifically shown on the drawings.

C. Detail drawings are located in large format AV drawings.

PART 3 - EXECUTION

3.1 AUDIO VIDEO SYSTEM REQUIREMENTS

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A. Requirements herein refer to materials and work which are related to or part of the Systems. Where conflict exists with other specifications concerning such work or materials, this specification takes precedence unless otherwise approved in writing by the Architect.

3.2 AUDIO VIDEO SYSTEMS INSTALLATION

A. All equipment must be installed in such a manner and in locations that allow for access for maintenance and repair. Equipment racks must be placed in the rack rooms to permit full access for operation and service.

B. Furnish and install all necessary brackets, braces and supports. All mounting hardware shall be included. AV devices may require additional support and/or backing in stud walls or ceilings to support the weight of the device. Contractor must furnish and install all support and backing as necessary for proper and safe installation.

C. All bolts and fasteners must be Grade 5 or better.

D. All bolted attachments to have lock washers or other self-locking fasteners.

E. Provide all required mounting brackets and framing, hardware and components, safety systems and rigging systems using the following minimum design factors (given as ratio of working load limit (WWL) : rated breaking load):
   1. 5:1 – Minimum design factor for all mounting components regardless of mounting condition.
   2. 8:1 – Minimum design factor for all hardware and connecting assemblies between manufacturer rated assemblies when equipment is not hung above the general public.
   3. 10:1 – For all hardware and connecting assemblies between manufacturer rated assemblies and supporting structure when equipment is hung above the general public and for all single point rigging suspension.
   4. Design factor calculations to be provided with all equipment mounting details.
   5. Systems Contractor shall coordinate required additional blocking, supplemental steel or channel strut supports with Main Contractor & specific trade contractors.
   6. All mounting systems not provided as a complete package from a single manufacturer must be engineered, approved, and have drawings stamped by a professional rigging engineer or licensed structural engineer, as approved by the Main Contractor. The engineer shall verify that the design meets or exceeds design criteria for this particular use case. Each mounting system solution must be separately engineered, verified, and stamped.

F. All supporting structures and enclosures supplied by the Contractor not having a standard factory paint finish shall be painted. Paint specifications will be supplied by the Architect or indicated herein.

G. Provide custom color or finish for any panels, or materials supplied which are in public view and for any equipment where specified. Request information on color and finish from the Architect.

H. Finish of blank panels and custom assembly panels shall match adjacent equipment panels. All color choices should be clearly indicated on panel drawing submittals, and on the panel schedule submittals

I. Switches, connectors, jacks, receptacles, outlets, cables and cable terminations shall be logically and permanently marked. Custom panel nomenclature shall be engraved, etched or screened. Markings for these items are detailed in the drawings to ensure consistency and clarity. Verify any changes in working type size and/or placement with the Systems Designer prior to marking.

J. Protect equipment and related wiring where construction conditions may cause damage or environmental conditions exceed manufacturer’s specifications.

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3.3 CONDUIT

A. Review and coordinate Systems conduit installation with the electrical contractor to ensure proper operation of the Systems. Provide input to the electrical contractor so that they may complete the AV conduit riser submittal.

B. All wiring shall be in conduit unless authorized by the Architect, approved by the Systems Designer, and permitted by code. Exceptions are short runs at rack terminations where there is no means of connecting conduit to the equipment.

C. Where installed exposed, conduits shall be parallel with or at right angles to walls or ceilings and shall be supported from walls or ceilings by means of approved galvanized iron clamps or hangers. Conduit connections to equipment racks shall be insulated to maintain ground isolation.

D. Minimum size conduit shall be 3/4 inch. All conduit shall be sized for a maximum 40% fill, unless applicable codes require a lower maximum fill

E. No conduit run between pull boxes/termination boxes may exceed 100 feet in length, and no single turn may exceed 90 degrees.

F. No conduit run shall have more than 180 degrees of combined turns between pull boxes.

G. Conduit containing STP, UTP, and COAX wire types must be installed so that the final length of the cable runs does not exceed maximum cable lengths as stated in 3.7.N and 3.7.O.

H. Systems wiring is divided into wiring groups according to their nominal voltage levels. Cabling may be combined in a single conduit, and/or junction box(es) as long as all cables are of the same wiring group. Refer to the Major AV Drawings General Information sheet for information on conduit separations by cable type. Refer to major AV drawings Terminations Schedule for cabling, grouping, and destination details, by termination):

I. All conduits, within 6” of termination box, junction box, gutter or rack/ ladder tray, must be labeled with conduit group and destination of the opposite end of that conduit, as follows: “AV - <Group>- <opposite end>”. For example “AV – III – STGA-01”. Permanent marker on the conduit where it can be seen from the ground or nearest access point is acceptable.

J. Each termination does not require individual home run conduits. Conduits of like groups may be combined at junction boxes so that a smaller number of larger conduit sizes may be used instead of a larger quantity of smaller individual conduits.

K. Contractor must have written authorization from the Systems Designer for any conduit installation which does not conform to these requirements. The conduit separations above are based on the use of EMT conduit for all AV and other signals. Separations where Rigid conduit is utilized for AV systems and/or other adjacent systems may be halved. Separations where PVC conduit is utilized for AV systems and/or other adjacent systems must be doubled. Flex conduit is not allowed without written authorization for each separate instance. The Contractor must request information on separation adjustments for each instance where a different type of conduit than what is listed above is used.

3.4 ELECTRICAL POWER

A. Review and coordinate electrical power system installation including grounding with the electrical contractor to ensure proper operation of the Systems.

B. Verify that all AC power circuits designated for Systems equipment are wired with correct polarity and isolated ground. Report in writing any discrepancies found to the Architect for corrective action.

C. Provide distribution of electrical power within the equipment racks with a minimum of one spare AC receptacle for each four in use per branch circuit.

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D. All AV systems electrical power distribution and outlets are provided and installed per the Division of Responsibility Table (see 1.11)

E. DIV. 26 contractor is to provide engraved cover plates for all power receptacles used in the Audio Video Systems, both isolated ground, and standard circuits that are shown as provided by Electrical Contractor. The engraving must call out the panel number and the circuit number(s) for the circuit(s) connected to that particular receptacle.

3.5 STEEL SUPPORTS

A. Fabricate and install any supports so that the installation does not weaken or overload the building structure. Do not impose the weight of equipment or fixtures on supports provided for other trades or systems. No drilling or cutting of concrete beams, joists, or structural steel, nor welding to structural steel, will be permitted except as authorized, in writing, by the Architect.

3.6 BOXES

A. With the exception of portable equipment, all boxes, conduits, cabinets, equipment and related wiring shall be held in place and the mounting shall be plumb and square.

B. All boxes shall be securely mounted to building structure. All boxes shall be installed so that wiring contained in them is accessible. Install blanking devices or threaded plugs in all unused holes.

C. Wiring groups and circuits shall be isolated as indicated herein. Common pull or junction boxes are not permitted except as authorized, in writing, by the Systems Designer.

D. Clean all box interiors before installing plates, panels or covers.

E. Using permanent marker on the box or on wire tags, indicate the lengths of installed cable for all COAX and Category wiring inside the box.

F. Using permanent marker, inside the box, indicate the box name, for example “STGA”.

G. Ensure that all floor boxes can open and close without impediment from attached portable cabling or surrounding building elements such as audience seating.

H. Coordinate floor box, panel, and cover location and orientation with Electrical Contractor and Systems Designer prior to installation.

3.7 WIRING METHODS AND PRACTICES

A. Provide installation of all Systems wire and cable, ensuring proper:
   1. Pulling Tensions
   2. Quantities
   3. Types
   4. Lengths
   5. Routing
   6. Wire Group Separation
   7. Identification

B. The interconnection of equipment in a rack shall use the same wire by type as specified for runs external to racks unless otherwise indicated on AV single line drawings. All wiring within racks shall be direct between devices without splices.

C. Interconnection wire between amplifiers and loudspeaker transition panels will be type SP12 (refer to wire types on AV000)

D. Connector polarity shall be maintained except for terminations at equipment manufactured to other standards. If manufactured equipment can be ordered with, or internally set to, various standards, the equipment shall be configured as follows:
   1. Polarity for XLR style connector shall be: pin 2-high, pin 3-low, and pin 1-shield.

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2. Polarity for TRS style connector shall be: tip-high, ring-low, and sleeve-shield.

E. Spare wire runs of each group and type shall be pulled to each termination location. The number of spares shall be ten percent of those in actual use or one, whichever is greater.

F. Splicing of cables is not permitted between terminations of specified equipment.

G. Do not pull wire or cable through any box fitting or enclosure where change of raceway alignment or direction occurs without written approval from the Systems Designer; do not bend conductors to less than recommended radius. Employ temporary guides, sheaves, and rollers to protect cables from excess tension, abrasion or damaging bending during installation.

H. Provide wire pulling lubricants and pulling tensions in accordance with the wire and cable manufacturer's recommendations.

I. All wires shall be permanently identified at each wire end by marking with self-laminating adhesive labels fully covered with clear heat shrink tubing, and a chart kept of each wire's function. This applies to wire within a rack assembly as well as wire running in conduit.

J. Wire ends should be wrapped with heat shrink tubing. Each shield or drain wire should be covered with heat shrink to avoid unintentional connections.

K. Use Wago or Entrelec DIN rail mounted terminal blocks for all terminal block wiring connections. Do not exceed one wire per terminal connection point. Do not cut strands from conductors to fit lugs or terminals. Spare terminal blocks, equivalent to 10% of those in actual use, shall be provided.

L. Form, in an orderly manner, all conductors in enclosures and boxes, wire ways and wiring troughs, providing circuit and conductor identification. Tie using wraps of appropriate size and type. Limit spacing between ties to six (6) inches and provide circuit and conductor identification at least once in each enclosure.

M. Provide service loops, minimum 6', at each termination so that plates, panels, patch bays, and equipment can be dismounted and placed on an adjacent horizontal work surface allowing for safe service and inspection without disconnection.

N. Maximum installed length of Category cables is 200'

O. Maximum installed length of Coaxial cable for HD-SDI, 3G-SDI, 6G-SDI, and 12G-SDI is 200'

3.8 GROUNDING

A. Audio system wiring shall conform to the following procedures:
1. Audio equipment AC ground pins shall connect to AC isolated ground.
2. Audio equipment chassis shall connect to AC isolated ground or rack frames.
3. Audio rack frames shall connect to AC isolated ground bus in panelboard by means of #2 gauge (minimum) conductor.
4. Audio shields between AC powered pieces of equipment, where signal shield is tied to chassis ground, shall be directly connected to ground at the initiating end only. Capacitively terminate the receiving end with a 0.1µF capacitor.
5. Audio signal paths between AC powered pieces of equipment shall be connected using balanced lines and/or transformer isolation as required. No unbalanced signal paths may be connected to the patch bay.
6. Isolate all Systems wiring from racks, back boxes and conduit.
7. Isolate all Systems racks from conduit and other conductive surfaces. Use insulated bushings for conduit connections and a dielectric plinth between racks and conductive flooring materials.
8. AC isolated ground system shall be isolated from all other facility grounds except at the single point of connection at the AV isolation Transformer.

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9. All metallic conduit, boxes and enclosures shall be grounded in accordance with the current National Electrical Code.

B. Metallic enclosures containing active equipment shall be grounded with due regard for the minimization of electrical noise. This may include the provision of grounding conductors separate from the AC ground.

3.9 EQUIPMENT RACKS

A. The equipment racks shall be considered as custom assemblies and shall be assembled, wired and tested in the Contractor's shop. Assembly of racks on-site will not be permitted, without written approval from the Systems Designer (except for system wiring which must terminate directly to the patch bays via soldering, punch-down or other non-connectorized termination process).

B. Placement of equipment in equipment racks, as shown in the drawings, is for maximum operator convenience. Verify any changes in placement of the equipment with the Systems Designer before assembly.

C. All primary equipment racks shall contain at the top of the rack a single rack-unit rack panel containing both the contractor and consultant’s contact information.

D. Racks shall be installed plumb and square without twists in the frames or variations in level between adjacent racks.

E. All wire, cable, terminal blocks, rack mounted equipment, and active slots of card frame systems shall be clearly and logically labeled as to their function, circuit, or system. Labeling on manufactured equipment shall be by engraved plastic laminate or by thermal printer on adhesive tape, with white lettering on black background or dark background that is similar to panel finish.

F. Provide stiffeners to custom panels to prevent panel deformation during normal plugging or switching operations.

G. All wires and cables used in assembling custom panels and equipment racks shall be formed into harnesses which are tied and supported in accordance with accepted engineering practice.

H. Harnessed cables shall be combed straight, wrapped every six (6) to ten (10) inches, and attached to the structure as necessary. Each cable that breaks out from a harness for termination shall be provided with an ample service loop so that panels, patch bays, and equipment can be dismounted and placed on an adjacent horizontal work surface allowing for safe service and inspection without disconnecting.

I. Harnessed cables shall be formed in either a vertical or a horizontal relationship to equipment, controls, components or terminations.

J. All system components and related wiring shall be located with due regard for the minimization of induced electro-magnetic and electrostatic noise, for the minimization of wiring length, for proper ventilation, and to provide reasonable safety and convenience for the operator.

K. All rack mounted equipment, with front panel controls, shall be provided with security covers to avoid tampering with preset levels. If specific security covers are not included in the equipment list, the Contractor will provide the manufacturer's security cover for each specified device or a suitable alternate.

L. All rack-mounted network switches shall be provided with rear-facing ports (if available) or else mounted to the rear rack rails of the equipment rack to avoid accidental unpatching.

M. Every device shall be installed with regard for proper polarity. Absolute polarity shall be maintained through the entire Systems signal chain.

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N. Any permanently mounted electronic device must be balanced. Contractor will provide balancing transformers for unbalanced equipment connections where necessary.

3.10 SYSTEMS CONTRACTOR TESTS

A. The Systems Contractor must test all the systems and systems components, as described below, prior to Systems Designer Testing and Commissioning. At the conclusion of the Systems Contractor Testing, the Systems Contractor will submit a Written Statement of Completion and test reports indicating test results, including failed tests and re-tests to clear the failures. Test reports shall individually reference every criteria mentioned below.

B. Test each point-to-point wire segment individually, and test any linkage of multiple point to point cables that form an end to end link.

C. Provide wireless frequency coordination reports, to include any existing wireless equipment and results of any on-site frequency scans.

D. Contractor must document all test requirements and results for submission (see 3.12 below).

E. Confirm that each individual wire and cable run (whether in a rack or in conduit) is identified with a unique number. These numbers are affixed to both ends of each cable and are clearly visible. Provide a complete list of these numbers along with the termination location of each end of the wire run.

F. Verify all circuits and extensions for correct connection, continuity and polarity. Absolute polarity must be maintained between all points in the system.

G. Identify installed length of all copper and fiber cabling.

H. Confirm that all system outputs are free of spurious signals including oscillations and radio frequency signals. A wide band oscilloscope shall be used to verify this condition.

I. Confirm that the system is free of audible clicks, pops, and other noises when any operating control is activated, with or without input signal.

J. For MIC, LINE, ACOM, SP48(signal pair), CTRL, AND MIDI cable types, confirm:
   1. Proper circuits appearing at each termination location
   2. Proper circuits appearing at each jack bay position
   3. Continuity of all conductors
   4. Proper polarity is maintained
   5. Absence of shorts between conductors within each circuit
   6. Absence of shorts between circuit conductors and conduit
   7. Perform a sweep test to 0.5MHz

K. For ANTS, and ANTL cabling confirm:
   1. Verify that TDR impedance is 50 +/-3 ohms
   2. Frequency sweep test from 5MHz to 1000MHz.

L. For VIDSDI cabling confirm:
   1. Verify that the installed cable meets, at a minimum, the requirements set forth in SMPTE ST 2081 for 6G-SDI single-link and 12G-SDI dual-link.
   2. Verify that TDR impedance is 75 +/-3 ohms
   3. Frequency sweep test from 5MHz to 6GHz.

M. For STP and UTP cabling:
   1. Use Category 6A cable pair tester to verify compliance with TIA/EIA standards referenced above (including all current addendums)
   2. Test each cable using the permanent link procedure for opens, shorts, reversals, cross twists and mis-wiring. Check NEXT, ELFEXT, Delay Skew, Return Loss, and Alien Crosstalk.

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3. Report all mis-wiring or failures found and report retests as needed.
4. If any conductors report open or short, replace the entire wire and re-test.
5. Submit TIA/EIA test reports generated by the test device.

N. For OS2 and OM4 Fiber cabling:
1. Using appropriate test devices and proper factory terminated jumpers, measure all fiber optic line attenuations, end to end, as required by TIA/EIA-526-14A.
2. Optical budget may not exceed the cable performance by length plus splice and connector losses (0.03 dB for each fusion splice, 0.3dB for each mechanical splice, and/or 0.4 dB for each connector).
3. Overall attenuation must meet TIA/EIA-568B standards. Perform attenuation tests at 850nm and 1300nm as appropriate.

O. Confirm that loudspeakers and mountings are free of buzzes and rattles when the loudspeaker is swept with sine wave tones over its rated bandwidth at one-half (1/2) its maximum rated power.

P. For all permanently mounted loudspeaker terminations, provide impedance measurement of each pair of loudspeaker lines with all loudspeakers connected and all amplifiers disconnected. These measurements shall be documented as editable tabular data listing impedance for each 1/3 octave band from 20 Hz to 20 kHz and shall be accurate to the nearest tenth of an Ohm.

Q. For all intercom terminations, confirm proper operation by initiating and receiving audio communication and call light. For single lines connected to a matrix, test each line with each channel in the matrix. Verify that all channels are quiet and without spurious noise.

R. For all electronic devices mounted in racks and connected to patch bays, confirm:
1. Every input and output is balanced.
2. Proper polarity is maintained throughout the entire audio path.
3. Tip connection of each TRS jack is connected to the positive terminal of each corresponding input or output.

S. For all devices requiring IP addressing:
1. IP addressing scheme must make use of subnets such that all devices, regardless on which network (Audio, Video, Control, or House) they reside, have a unique IP address to eliminate the possibility of duplicate IP addresses if networks are inadvertently cross-patched.
2. All devices must have static IP addresses.
3. Create a spreadsheet of all devices and their IP addresses, Subnet Masks, MAC Addresses, and other pertinent IP configuration information.
4. Coordinate all IP addressing schemes with the Owner.

T. If the Audio, Video, and Control network switches are dedicated to these systems and the systems do not rely on Owner furnished and configured network switches:
1. Configure network switches to operate properly and provide the proper network configurations to support the network devices and protocols used by those devices.
2. Configure, as needed, VLANS, IGMP, QOS, and other protocols requiring configuration to provide a fully functioning and robust network system.
3. With all networks configured and operating, and all network devices configured and operating, confirm that the networks are behaving as expected and as required.

U. Electrical Contractor, coordinating with the Systems Contractor must confirm that there are no shorts between the Neutral and Isolated Ground conductors, and between the isolated ground conductor and building ground for each AV Technical Power circuit. Electrical Contractor, coordinating with the Systems Contractor must confirm there are no Bootleg Grounds or Neutral-Ground Reversals on each AV Technical Power circuit.

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V. The Contractor is responsible for the programming and configuration of all DSP systems and control systems necessary as specified in this project specification and AV large format drawings.
   1. Programming and configuration must be complete and ready prior to System Designer's arrival for verification of functionality and acceptance testing.
   2. Programming for the DSP systems must contain control pages to support normal operations, and to support Systems Designer Testing and Commissioning operations, as described in this specification and the large format AV drawings.
   3. Programming for the Control Systems must include all master controller code and touch panel code and graphics, working together to provide the function as described in this specification and the large format AV drawings.

W. Test all Audio, Video, and Control system controls, including but not limited to mixing consoles, switchers, routers, touch panels, paging stations, volume controls, and source selectors for proper operation.

X. Test proper operation of any portable controls at each designated control location (Stage Manager's rack, for example).

3.11 SYSTEMS CONTRACTOR INITIAL SETTINGS

A. All initial adjustments must be documented and submitted as part of the Systems Contractor Test Reports (see 1.5.C.3.j.ii and 3.12).

B. Make all adjustments and modifications so that the system is operational and fully functional including but not limited to:
   1. Update all device software and firmware to the latest manufacturer's recommended release that allows for proper operation with ALL OTHER DEVICES in the systems.
   2. Make all adjustments and modifications for system gain structure per recommendations of major component manufacturers.
   3. Properly configure all EDID and HDCP settings to allow for proper function of all video systems.
   4. Install all programming for digital mixing consoles, DSP, Control and any other software-based devices in the systems, and verify that audio and video signal passes as designed through these systems. Verify that control systems function as specified. Refer to Section 1.3 for full scope of work description for programming.
   5. Properly balance all 70 Volt loudspeaker zones to be consistent from zone to zone using amplifier settings and loudspeaker taps to adjust for differing loudspeakers or installation height. All 70 Volt loudspeakers within a given zone must not have a broadband SPL variation of greater than +/- 2dB from center of speaker to center of speaker.
   6. Equalization and timing of the loudspeaker systems shall be further adjusted as required by the Systems Designer and Owner during Systems Designer Testing and Commissioning.

3.12 SYSTEMS CONTRACTOR TESTING REPORTS

A. Submit written report detailing the results of Initial Adjustments and Systems Contractor Tests. Report to include, at minimum, the following:
   1. Copies of all relevant drawings, charts, test instrument data, and photographs.
      a. PDF copies of all available manufacturers' operation and service literature for each major system component.
      b. Copy of all programming files including, but not limited to, Audio DSP programming and Graphic User Interface (GUI) files, Control system Touch Panel GUI files and control system control programming files including un-compiled source codes.
      c. All other documentation and results of testing and initial settings as referenced in 3.10, and 3.11 above.

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d. Written certification that the installation conforms to the requirements stated herein, is complete in all respects, and is ready for inspection, Acceptance Testing, and tuning.

2. Prepare and submit an Avixa standard Commissioning Checklist for each system in this specification.
3. Prepare and submit a training syllabus for Owner training (see section 3.14).

B. This report shall be completed and submitted to the Systems Designer for review a minimum of five (5) days prior to Systems Designer Testing and Commissioning.

3.13 SYSTEMS DESIGNER TESTING AND COMMISSIONING

A. Systems Designer Testing and Commissioning shall be performed by the Systems Designer and Contractor during a period designated by the Architect. Contractor shall furnish a minimum of one (1) technician or one technician per Systems Designer commissioning team, for the acceptance testing period, and one or more engineers fully capable of programming DSP and Control systems and making any other engineering adjustments to equipment in the systems. Contact Systems Designer for number of commissioning teams that will be deployed.

B. The minimum time required for Systems Designer Testing and Commissioning is one (1) working day, including four (4) days of dedicated quiet time. Coordinate this time period so that free access, work lighting, and electrical power are available on the site.

C. Ensure that Systems areas are in a clean and orderly condition ready for acceptance testing.

D. Provide test equipment (meeting the following minimum specifications) on site, at all times during Systems Designer Testing and Commissioning. Prior to testing, provide the Systems Designer with a listing of the specific equipment to be made available (#).

1. Oscilloscope: 10MHz Bandwidth, Sensitivity – 1mV/cm
2. Digital Multi-meter: 1% Accuracy
3. Function Generator: 1MHz Bandwidth, Distortion < 1%
4. Real Time Analyzer: 1/3 Octave with microphone
5. SMAART Analysis package with V.8 software and a minimum of two matching test microphones (Earthworks M30 or better)
6. Pink Noise Source: 20 Hz – 20 kHz Bandwidth
7. Test mic tone calibrator
8. Impedance Sweep Meter: 20 Hz – 20 kHz Range, 1 Ohm – 50 kOhm
9. Polarity Checker: Mic, line, or loudspeaker level
10. Video Test Signal Generator(s): must provide all signals, resolutions, and output formats as needed to fully test the systems.
11. Systems Designers may choose to supply some of their own test equipment. Confirm specific requirements prior to commissioning

E. Be prepared to verify the performance of any portion of the system by demonstration, listening tests and instrumented measurements.

F. Be prepared to facilitate the visual inspection of system components and wiring, including removal of termination panels for inspection of wiring termination and wire management practices.

G. Be prepared to demonstrate all software and control systems.

H. Be prepared to go through the commissioning checklist and verify all items as complete.

I. Make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Systems Designer as a result of the Acceptance Tests. This may include focusing of loudspeaker systems, changes in system gain structures, grounding, filtering or interfaces.

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J. Contractor will bear any costs incurred for additional Systems Designer's time and expenses due to failure to have the system functioning in accordance with specification requirements at the times scheduled for Systems Designer Testing and Commissioning.

3.14 USER TRAINING

A. Contractor will provide in-depth training in operation and regular maintenance of all systems and on all equipment included in the scope of work contained in this specification and the AV large format drawings.

B. Training to include (but is not limited to):
   1. Required Manufacturer provided training.
   2. Detailed operation of mixing consoles, video switchers and routers, computer control systems and other essential system elements as relevant to their installation in this project.
   3. Maintenance and repair of system equipment, including replacement procedures for user-replaceable parts.
   4. Review of Operation and Maintenance Manual (See 3.15)

C. Contractor will provide a minimum of six (6) training sessions of four hours each with times and dates to be approved by the Owner.

D. The first session shall take place in the presence of the Systems Designer and shall occur directly after the completion of Systems Designer Testing and Commissioning. If the Systems Designer, Owner, and/or Architect judge any work to be deficient and/or not substantially complete at the time scheduled for training, the training will be postponed until the Systems Designer, Owner, and Architect judge the entire AV system conforms to this specification and the AV large format drawings.

E. Contractor will bear any costs incurred for additional Systems Designer's time and expenses due to failure to have the system functioning in accordance with specification requirements at the times scheduled for User Training.

3.15 SYSTEMS DOCUMENTATION

A. Systems Designer will review the Systems Documentation submittal (see 1.5.C.3.k) Upon approval of the documentation submittal, the Contractor will prepare five electronic copies stored on five separate USB storage devices and submit four to the Owner and the fifth to the Systems Designer.

3.16 FINAL ACCEPTANCE

A. Final acceptance will be contingent upon issuance by the Systems Designer of a letter of acceptance stating that the work has been completed and is in accordance with the contract documents.

APPENDICES TO FOLLOW

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APPENDIX A – AUDIO VIDEO NARRATIVE

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APPENDIX A – AUDIO VIDEO NARRATIVE

INTRODUCTION

The Auditorium is a new venue located in new 7th and 8th School Building. It will be used for many school functions, including lectures, music department concerts, and small scale theatrical performance.

1. FACILITY-WIDE AUDIO VIDEO

1.1 OVERVIEW

The venue detailed herein and their support spaces will be designed as an integrated solution. To achieve this goal, many of the AV technical systems are interconnected, allowing fluid exchange of audio and video material for various purposes.

1.2 VIDEO TRANSPORT SYSTEM

The design features a networked video transport and matrix system allowing staff and users a flexible and efficient approach to routing sound and video feeds to various locations. The system uses a series of networked video encode and decode devices that patch to a facility wide video LAN. Interconnections are achieved through control software and touch panel controllers, digitally connecting or disconnecting feeds from and to any display.

1.3 PRODUCTION NETWORKS

The Audio, Control, and Video production networks are provided to transport audio, video, and control signals throughout the facility. These networks are isolated from other building networks with the possible exception of a single connection to the public internet. This connection is to be coordinated between the owner and AV contractor so that the contractor can provide remote support if that is desired.

1.4 AV EQUIPMENT RACKS

Audio video equipment racks are located at various locations around the facility and will become the backbone of the system with space for:

- The digital signal processors (“DSP”) used to time align, “tune” and control the main loudspeaker systems. These devices are selected for compatibility with the primary mix console and loudspeakers.
- Control and processing for the auxiliary systems, which includes ADA-compliant listening assistance, production intercom, background music, program and paging systems.
- The video distribution network system.
- Amplifiers for loudspeakers and auxiliary audio systems.
- Wireless receivers and monitoring equipment.

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2. AUDITORIUM

2.1 PERFORMANCE AUDIO SYSTEM

The performance audio system in the theatre is intended to support a wide range of productions from voice reinforcement, to concerts, to theatrical presentations.

Main Left, Right and Center loudspeaker arrays and a Subwoofer array will provide quality, full bandwidth coverage to the majority of the audience area to a maximum sustained output level of 95 dB +/- 6dB.

Delay loudspeakers are provided to extend high quality sound to the side rear of the seating area.

Front fill loudspeakers are provided at the stage lip, to support coverage in the very front rows and allow better gain before feedback in the system, by keeping much of the spill form the main loudspeakers off the stage area.

The stage will have dedicated panels for audio inputs, outputs and speakers. Additional inputs and outputs can be easily added by connecting a stage box to multi-channel digital ports on these panels.

A digital console, located at the house mix position, is the primary mix platform which in turn feeds the loudspeaker systems, and a digital signal processor which feeds the auxiliary systems.

A computerized audio playback system is integrated with the FOH mixing console to provide a sonic palette for sound effects and recorded music.

2.2 ASSISTED LISTENING SYSTEM

This system transmits stage sound or other selected program material by means of bluetooth wireless to individual receivers or user provided devices for the hearing impaired. Alternate uses of the system include transmission of audio descriptions for the sight impaired or simultaneous translation.

2.3 LIVE ROOM MICROPHONE SYSTEM

A microphone suspended in the audience chamber picks up signals from all performances, both amplified and unamplified. Signals from this source, potentially mixed with console outputs are distributed to a number of auxiliary systems, including hearing assistance, intercom, and the Program/Page Matrix. In addition, this source can be used to feed streaming video.

2.4 PERFORMANCE & PRODUCTION VIDEO

A video projector and motorized projection screen will be permanently mounted in the

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theatre to provide primary video support for any of the uses of the theatre.

A broadcast quality Pan Tilt Zoom (PTZ) camera is permanently installed to provide video feeds to the screens and the rest of the facility and live stream as needed.

A computerized video playback system is provided which allows for easy playback of presentations or artistic manipulation of recorded video material.

An infrared camera is mounted in the space to allow viewing of the stage, including under low and no light level conditions for safety purposes at the Stage Manager position.

2.5 AV EQUIPMENT RACKS

There will be, at minimum, permanent amplifier racks and signal processing racks in a dedicated rack room as well as support racks at the control room.

2.6 WIRELESS MICROPHONE SYSTEM

A digital wireless microphone system is included with both handheld and beltpack transmitters. Eight channels of wireless is anticipated to fill general needs in the space. If a specific event required more channels additional wireless could be borrowed or rented and integrated into the system.

2.7 AV LOOSE EQUIPMENT

Wired microphones, DI boxes, cables, stands as appropriate to the program are provided.

2.8 PRODUCTION INTERCOM

Communication is key for the creation of performance arts. The design will utilize digital partyline intercom to allow technical operating personnel using headsets with boom-mounted microphones to communicate with each other and the front of house staff as needed. Stations and plugin ports are provided for all technical operating positions on the stage, in the spotlight mezzanine, and backstage support areas as needed. Digital wireless beltpack units are utilized for backstage personnel who need maximum mobility around the stage, dressing rooms, and other back of house areas.

2.9 AV CONTROLS

For simple events where a qualified AV technician is not in attendance a touch panel control system will allow any staff member the ability to show a video, run a presentation, and use a handful of the wireless microphones.

2.10 LIVE STREAM SYSTEM

A modest Live Stream system is supplied that can be used with the PTZ camera and/or any video source in the performance space.

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3. AV ALTERNATE

An alternate calls for elimination of all devices and wire EXCEPT those required for the projection system. Devices retained are marked with an asterisk in Appendix B – Major Equipment List and noted on contract drawings. All conduit and back boxes and are to REMAIN, including electrical power accommodations.

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APPENDIX B – AUDIO VIDEO MAJOR EQUIPMENT LIST

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APPENDIX B - AUDIO VIDEO MAJOR EQUIPMENT LIST

Items with an asterixk are RETAINED if AV Alternate is acccepted. All others are eliminated

	Qty	Manufacturer	ITEM	DESCRIPTION
DSP and Control				
*	1	QSC	Q-SYS Core 24F	DSP Core - 160x160 i/o, 24 AEC, 8x8 + 8 flex analog i/o, Dante 8x8 Lic. to 64x64
	4	Atterotech	D2I	2 XLR Wall Plate 2in w/ Axom port
*	2	QSC	TSC-70-G3	Touch Panel 7"
	2	Atterotech	unD6IO-BT	Bluetooth & 1/8" Interface Wall Plate
	1	QSC	Dante 32x32 License	Dante 32x32 License
	1	Middle Atlantic	UPS-S2200R	2200VA UPS Backup
Console				
	1	Allen & Heath	SQ-7	Mixing Console 48 input 33 faders
	2	Allen & Heath	DT168	16in 8out Remote Rack Dante
	1	Allen & Heath	SQ Dante64	Dante 64 Channel card for SQ, AHM
	2	Middle Atlantic	UPS-S500R	500VA UPS
Wireless				
	2	Shure	ULXD4Q	Quad Receiver
	8	Shure	ULXD1	Bodypack Transmitter
	8	Shure	ULXD2/SM58	Handheld Transmitter
	8	Point Source Audio	CO-8WD	Headeset mic, Omni, confirm color and sensitivity
	16	Shure	SB900B	Batteries
	1	Shure	SBC800	8 bay Charger for SB900 Batteries
	1	RF Venue	Diversity Architectural Antenna	Diversity Antenna for UHF Wall or Ceiling Mount, 140 Degree, confirm white or black
Video				
	1	Panasonic	AW-UE80	4K PTZ Camera 1/2.5 Sensor, Dome Style
*	1	Draper	114619	14-9 tall 16:10 Matte White Motorized Paragon V Tab Tensioned
*	1	Epson	EB-PU2220B	20k 3 LCD WUXGA with 4k Enhancement, 19k at 120V
*	1	Epson	ELPLM10	Middle Throw Zoom Lens 2.42-3.71
	1	Blue Mango	BMH-S18	HD Box Camera, HD-SDI Out, Day or Night
	1	TBD	Camera Lens	Manual Zoom Auto Iris Camera Lens C/CS Mount
	1	Decimator	Decimator 2	SDI 3G to HDMI Converter
	1	Axis Communications	T90D30	IR LED (POE)
	1	Airserver	Airserver Connect 3	Network video sharing platform
	1	Visionary	DuetE-5	Encoder 4k60 4:4:4 1 Gig Ethernet HDMI In with Dante & USB
	3	Visionary	D5000	Encoder 4k60 4:4:4 1 Gig Ethernet HDMI In
*	1	Visionary	DuetD-5	Decoder 4k60 4:4:4 1 Gig Ethernet HDMI Out with Dante & USB
	2	Visionary	DuetD-5	Decoder 4k60 4:4:4 1 Gig Ethernet HDMI Out with Dante & USB
	1	Visionary	E5000	Encoder 4k60 4:4:4 1 Gig Ethernet HDMI In
*	1	Visionary	E5000	Encoder 4k60 4:4:4 1 Gig Ethernet HDMI In
*	2	Visionary	DuetE5-WP	Wallplate Encoder 4k60 4:4:4 1 Gig Ethernet HDMI In with Dante & USB
	1	Marshall	ML-702	Dual 7" Monitors
Speakers and Amps				
	2	Fulcrum	DX12	Dual 12" Speaker
	2	Fulcrum	CC215	12" Constant Curvature 100x15 Loudspeaker
	1	Fulcrum	CC230	12" Constant Curvature 100x30 Loudspeaker
	8	Fulcrum	CX8	8" Speaker
	2	Fulcrum	RX6	6" Coaxial Speaker 90x75
	5	Fulcrum	RX4	4" Coaxial Speaker 100x100
	1	Fulcrum	CS118	18" Cardioid Subwoofer
	2	Fulcrum	YK-DX12	Yoke for DX12 Speaker
	1	Fulcrum	LBKM	Link Bar Kit for CCS18 - Mixed (CCS18 + CC215/CC230 Arrays)

1	Fulcrum	LBK230	Link Bar Kit for CC230
2	Fulcrum	LBK215	Link Bar Kit for CC215
1	Fulcrum	VAFK	Vertical Array Frame/Extension Bar Kit for CCxxx Series
8	Fulcrum	YK-CX8	Yoke for CX8 Speaker
5	Fulcrum	UB-RX4	Yoke for RX4 Speaker
2	Fulcrum	UB-RX6	Yoke for RX6 Speaker
8	The Light Source	SCB	30" Safety Cable for portable speakers with Snap Hook
8	The Light Source	Mega Claw Black	Mega Claw Clamp - Black
1	QSC	CX-Q 2k4	4 Channel 500W/ch Network Amplifier
2	QSC	CX-Q 4k8	8 Channel 500W/Ch Network Amplifier
2	QSC	NL-C4	POE Network 4" Ceiling Speaker
2	Adaptive Technologies	SAS-100-2	Wall Arm Mount
Microphones			
2	BSS	AR133 Direct Box	Direct Box
2	Radial	JDI Stereo Direct Box	Stereo Direct Box
6	Shure	SM57	Dynamic Microphone
6	Shure	SM58	Dynamic Microphone
4	Audio Technica	AT4021	Small Diaphragm Condenser Microphone
4	Crown	PCC160	Boundary Microhone
1	Sennheiser	MEG 14-40	Podium Microphone
1	Audio Technica	BP4027	Stereo Shotgun Microphone
Cable, Stands, hardware			
4	K+M	260	Weighted Base Microphone Stand
6	K+M	210/9	Tripod Mic Stand with Boom Arm
2	K+M	259/5	Short Tripod Mic Stand with Boom Arm
4	K+M	240/5	Clamp Mic Stand
8	Whirlwind	NL4-002	2' NL4 Cable 12AWG
6	Whirlwind	SK510G12	10' NL2 Cable 12AWG 1+/1-
6	Whirlwind	SK525G12	25' NL2 Cable 12AWG 1+/1-
4	Neutrik	NL4MMX	NL4 Turnaround
5	Whirlwind	MK403	3' XLR Cable
5	Whirlwind	MK406	6' XLR Cable
5	Whirlwind	MK410	10' XLR Cable
5	Whirlwind	MK425	25' XLR Cable
3	Neutrik	NA3FF	XLR to XLR Turnaround, Socket to Socket
3	Neutrik	NA3MM	XLR to XLR turnaround, Pin to Pin
2	Whirlwind	SN03	3' TS Cable
4	Whirlwind	SN06	6' TS Cable
2	Whirlwind	ENC6ASE03	3' Cat6A Cable
2	Whirlwind	ENC6ASE06	6' Cat6A Cable
2	Whirlwind	ENC6ASE10	10' Cat6A Cable
2	Whirlwind	ENC6ASE25	25' Cat6A Cable
Network			
* 2	Netgear	GSM4230PX	Network Switch 24 1G port with SFP+ and POE+
1	Netgear	GSM4248PX	Network Switch 40 1G port with POE+ and 8 SFP+
* 2	Netgear	AXM764	SFP+ Single Mode 10Gig Fiber Transceiver
2	Netgear	AXM764	SFP+ Single Mode 10Gig Fiber Transceiver
1	Netgear	PR460X-111NAS	Network Router 6 10G ports
2	Netgear	AX4200	USE WAX220 - WAP WiFi 6 Dual Band with multigig ethernet port
1	TBD	POE++ Injector	POE++ Power Supply (for Axis LED)
Computers			

	2	Apple	14" Macbook Pro	14" M3 Laptop Computer with 16GB RAM, 1TB SSD
	1	Figure 53	Qlab	Audio and Video License
	2	Visionary	DuetE-5	Encoder 4k60 4:4:4 1 Gig Ethernet HDMI In with Dante & USB
	1	Apple	iPad	Tablet Computer
	2	TBD	USB-C to Ethernet Adapter	USB-C to 1Gb Ethernet Adapter
	1	Sonnet	Thunderbolt Dual 4k HDMI 2.1 Adapter	Thunderbolt to Dual 4k HDMI Adapter
	1	Denon	DN-500BD MKII	DVD/CD/Blu-Ray Player with USB Playback
Intercom				
	2	Clearcom	RM-702	2 Channel Remote Station
	1	Clearcom	PS-702	2 Channel Power Supply
	1	Hollyland	Solidcom M1 8B	Wireless Intercom, 8 Full Duplex beltpacks w/ single muff lemo, hub w/ wired interface
	2	Clearcom	RS-702	Two Channel Beltpack
	6	Clearcom	RS-701	One Channel Beltpack
	8	Clearcom	CC-110 Headset	Headset lightweight signle muff
Racks				
*	1	Middle Atlantic	BGR-4532-AV	45RU Floor Rack 32" deep - preconfigured for AV
	1	Middle Atlantic	BGR-4532-AV	45RU Floor Rack 32" deep - preconfigured for AV
*	1	Middle Atlantic	EWR-16-22SD	Wall Mount, 16RU, 22" Deep, Swinging, with door
	3	Middle Atlantic	RK6	6RU Wood Rack, no rear rail, 15.9" Deep
	1	Middle Atlantic	Rack Power	MPR, RLM, PD series power components as required
	1	Middle Atlantic	Rack Hardware	Lacing Bars, Cable Management, Blank Panels, Shelves as required
	2	Middle Atlantic	TD2	Rack Drawer 2RU with latch
	6	Middle Atlantic	TD3	Rack Drawer 3RU with latch
	1	Middle Atlantic	5-14 Slim Rack	14RU Slim Rack 19.25" wide, 26" deep
	1	Middle Atlantic	SSL	Slide Out Shelf 1RU Black Laminate
Assisted Listening				
	1	Listen	RF Receivers 12 pack with Charger	Receivers 12 pack with Charger
	1	Listen	AURI-TX2N-D	Auri Bluetooth Transmitter w/ Dante
	1	Listen	AURI-D16	Auri 20 Bay Charging Station
	22	Listen	AURI-RX1	Auri Bluetooth Receiver
	6	Listen	LA-438	Advanced Neck Loop
	22	Listen	LA-165	Stereo Headphones
	1	Listen	AURI-D4	Auri 4 Bay Charging Station
Streaming				
	1	Apple	14" Macbook Pro	14" M3 Laptop Computer with 16GB RAM, 1TB SSD
	1	FeelWorld	Seetec SC173-HD-56	Rack Drawer Mount 17.3" FHD Monitor HDMI 4k60 Input
	2	Visionary	DuetD-5	Decoder 4k60 4:4:4 1 Gig Ethernet HDMI Out with Dante & USB
	1	Black Magic	ATEM Mini Pro Iso	Switching, Streaming and recording Hardware
	1	TBD	USB-C to Ethernet Adapter	USB-C to 1Gb Ethernet Adapter

APPENDIX C – AUDIO VIDEO CONTROL NARRATIVE

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APPENDIX C – Audio Video Controls Narrative

The following is a brief description of AV system control functions that must be present on the project, whether automatic or triggered by a control interface on the project. While every attempt is made to include common functions, owner requests or functions specific to a location will be incorporated as the project progresses.

FACILITY WIDE

1. General Notes
    a. Control system buttons should represent real feedback from system, not button press feedback. For operations where the action being initiated is not instantaneous, button feedback should indicate that an action is in progress (a video source switch, as an example).
    b. All control system buttons are to be appropriately sized. All buttons shall be of a relatively similar scale excepting specialty buttons that appear when a Priority Announcement or Fire Alarm ends, these should be larger than typical.
    c. Touch panel graphics shall be coordinated with client graphic standards. Client text styles, colors, and logos shall be incorporated into the graphic user interface (GUI) design.
    d. Color alone is insufficient to denote the state of any button or control. All controls must have a consistent method of showing text or graphic feedback in addition to color. e.g. a “Mute” button may turn red to indicate the mute status but must also change either text e.g. “Muted” or graphics e.g. inverted highlights, to show the change.
    e. All touch panels and control devices shall run separate GUI files - no interfaces shall run a single file. This is intended to allow all control devices to operate independently.
    f. Depending on the size of the touchscreens, some functions may be able to be condensed or must be separated into additional pages. Please keep all similar controls together. The GUI layout and Configuration submittals are critical to assessing the layout and DSP configurations.
    g. The Venue will run under two modes:
        i. CLASSROOM: General day to day use throughout the school day
            1. In this mode 4 wireless microphones, 4 onstage wired microphone inputs, and Bluetooth inputs are available along with audio from video.
            2. All microphones should be routed to the auditorium and overhead speakers on stage.
            3. Audio from Video will be routed only to the auditorium speakers.
        ii. PERFORMANCE: Engaged when additional technical expertise is required for complex operations, e.g. a music or theatrical performance.
            1. No audio control is available on the touch screen, physical mixer receives all inputs and sends all outputs.
            2. Setting and recalling of projector presets is available.
2. General system functions
    a. Fire Alarm
        i. The AV systems must mute when a fire alarm is activated by way of a relay connection provided by the fire alarm installer. A message stating “Fire Alarm” will be shown on all touch panels. Touch panels will not respond to any touches while “Fire Alarm” is shown. All outputs should be muted in processing and can be brought back online only after the fire alarm is cancelled by pressing an “Unmute” button shown on all touch panels.
    b. Announcements
        i. The AV systems must pass mute audio for school-wide announcements under different conditions. There is one relay input dedicated to school-wide announcements.

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1. School Day announcements, these are typical announcements played through the school wide public address system. The school PA system will trigger a relay and the AV system will respond as below:
    a. The AV systems will mute all other sources so the announcement can be heard.
    b. A message stating “Announcement” will be shown on all touch panels.
    c. Touch panels will not respond to any touches while “Announcement” is shown.
    d. System will automatically unmute when the announcement completes with a 3 second fade to previous levels.
2. Performance Time Announcements, when a performance is in progress low priority announcements to the school will NOT trigger the AV system to mute and will NOT play through the announcement speakers in the theatre. However, urgent announcements such as extreme weather or active shooter can still be made if required and the muting sequence shown above will be activated. Performance Times are dictated by the school wide announcement system and can be scheduled according to the use of the theatre.

3. DSP is required at all stages to provide smooth audio and easy functionality, especially in Classroom mode. Noted below are basic parameters for system processing, additional processing may be required.
    a. Processing on Live Microphone and Page inputs as well as Program outputs are always active.
    b. Every output is fitted with a minimum of 8 bands of fully parametric EQ, two of which can be switched to high or low pass filters.
    c. All microphone inputs in Classroom mode must have compression and/or leveling as well as high pass filters and equalization set for general speaking use with a handheld microphone.
    d. Classroom mode will have overall compression and limiting on the sound system to keep the level within useful limits. Care should be taken to allow for natural sound reproduction of playback sources.
    e. Every effort in setting gain stages and processing must be made to avoid feedback in Classroom mode. System shall be tested under worst case conditions and adjusted to avoid feedback.
    f. Program Feed will be a combination of Live Microphone and Console sends to the main L/R speaker systems. A ducking circuit will allow the Console send to override the Live Microphone with a fast restore such that applause, laughter, and other audience reactions are heard clearly.
    g. Paging microphone inputs must have EQ, compression, and leveling to keep all pages clearly intelligible.
    h. Program Audio shall be embedded with the PTZ camera video signal.
4. PIN Code Access
    a. All Touch Panels not located in a secured room must be protected with a PIN code.
        i. PIN Code unlocks ONLY the touch panel upon which the code is entered.
        ii. PIN Code is required whenever the touch panel has been idle for more than 60 minutes.
5. Mode Selection
    a. All pages must show current mode on the page. Touching this button allows selection of CLASSROOM or PERFORMANCE mode. At the owner’s discretion an additional PIN code may be required to access the PERFORMANCE mode.
    b. Mode Selection also includes a button for immediately locking the touch panel by requiring the general PIN for any further access.
    c. When selecting a mode while system is powered on, a warning should be shown noting that audio and video may be interrupted with an OK or Canel response.
6. iPad Control
    a. All functions noted for touchpanel control will also be available on an iPad app.
    b. iPad will additionally be loaded with remote control software for the audio console, wireless microphone management, QLab remote control, video monitor control app (if available).

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7. Touch Panel CLASSROOM Mode pages
    a. Landing page
        i. System Power Toggle
            1. On
                a. Turns power on or takes out of standby mode all equipment other than video projectors.
                b. Starts warmup timer to allow all systems to be completely operational before use. Show graphic countdown.
                c. All audio levels retain settings from last shutdown of classroom mode.
            2. Off
                a. Mute all audio.
                b. Turns power off or puts into standby mode all equipment, including video projectors.
                c. Retracts projection screen
                d. Starts Cool Down timer for any devices requiring a cool down before restart. Show graphic countdown.
                e. Immediately requires General PIN for any additional functions.
        ii. Projector Power Toggle
            1. On
                a. Brings projector out of Standby Mode
                b. If only one video input is active, switch projector decoder to that input.
                c. If more than one video input is active display video input selection screen.
                d. Select the Presentation Preset on the projector
                    i. NOTE: The presentation preset shall be a permanent setting that recalls projector zoom, lens shift, keystone correction, color, and brightness for use with the screen. Other settings may be stored for alternate uses of the projector such as scenic projections or alternate screen surfaces.
            2. Off
                a. Put the projector in Standby Mode.
                b. Starts Cool Down timer if required. Show graphic countdown.
        iii. Projector Screen Toggle
            1. Down
                a. Lower screen to limits, this should line up exactly with the presentation preset of the projector.
            2. Up
                a. Retract the screen fully into its housing.
            3. Additional Screen Heights
                a. In some cases, there may need to be additional screen heights. e.g. a higher screen location for awards ceremonies or surtitles. In this case a drop down menu or other method of selecting the intermediate location will be located on this page. When the alternate screen location is selected the appropriate Projector Preset is also recalled.
        iv. Master Audio Level
            1. Fader showing master audio level for all systems
        v. Projector Video Input Selection Button
            1. Button that brings up the Video Input Selection Page
        vi. Audio Input Mix Button
            1. Button that brings up the Audio Input Mix Page
        vii. Help Button
            1. Brings up the Help Page
    b. Projector Video Input selection Page

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i. Thumbnail video previews of each source. Touching the preview assigns that source to the projector.
ii. When only one source is active at the time of projector startup, that source is automatically selected.

c. Audio Input Mix Page
i. Master Audio Level Fader for all systems: This fader must be graphically differentiated from the input faders and have the same appearance as on the Landing Page.
ii. Input faders for the following:
1. Wireless Microphone #1
2. Wireless Microphone #2
3. Wireless Microphone #3
4. Wireless Microphone #4
5. Video Audio from source currently selected to projector
6. Bluetooth Input
7. Wired Microphone #1 HSMI Mic 1
8. Wired Microphone #2 HSMI Mic 2
9. Wired Microphone #3 STMI Mic 1
10. Wired Microphone #4 STMI Mic 2

d. Help page
i. Contact information for in-house technical support.
ii. Phone and email information for the installing contractor.
iii. Basic help text as identified in coordination with the owner after several months of use to assist teachers and staff use the system.

8. Touch Panel PERFORMANCE Mode pages
a. Landing page
i. System Power Toggle
1. On
a. Turns power on or takes out of standby mode all equipment other than video projectors and Lobby/Backstage video monitors.
b. Engages audio through console.
c. Restores video routing from last Performance Mode use.
d. Starts warmup timer to allow all systems to be completely operational before use. Show graphic countdown.
2. Off
a. Mute all audio
b. Turns power off or puts into standby mode all equipment, including video projectors.
c. Retracts projection screen
d. Starts Cool Down timer for any devices requiring a cool down before restart. Show graphic countdown.
e. Immediately requires General PIN for any additional functions.

ii. Projector Power Toggle
1. On
a. Brings projector out of Standby Mode
b. Restores Projector Preset from previous Performance use.
2. Off
a. Put the projector in Standby Mode.
b. Starts Cool Down timer if required. Show graphic countdown.

iii. Projector Screen Toggle
1. Down

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a. Lower screen to limits, this should line up exactly with the presentation preset of the projector.
2. Up
a. Retract the screen fully into its housing.
3. Additional Screen Heights
a. In some cases, there may need to be additional screen heights. e.g. a higher screen location for awards ceremonies or surtitles. In this case a drop down menu or other method of selecting the intermediate location will be located on this page. When the alternate screen location is selected the appropriate Projector Preset is also recalled.

iv. Video Routing Button
1. Button that brings up the Video Routing Page
v. Projector Presets Button
1. Button that brings up the Projector Presets Page
vi. Camera Focus Button
1. Button that brings up the Camera Focus Page.
vii. Help Button
1. Brings up the Help Page

b. Video Routing Page
i. Thumbnail video previews of each source.
ii. List of video destinations with assigned source
1. Touching the source brings up a list from which a new source may be selected. The list should not cover the video previews of the sources.

c. Projector Presets Page
i. Presentation Preset Button
1. This is permanently set to match the presentation screen location.
2. If other screen heights are required, they are also represented here with permanent buttons
ii. Four custom preset buttons can be touched to recall or touch and hold to store. Provide positive feedback on successful storing of preset. Recalled presets' button should remain highlighted until another preset is stored, recalls or a projector setting is adjusted.
iii. Control buttons for Zoom, Focus, and lens shift are shown here. Notes for accessing additional settings such as color, brightness, or keystone correction are shown, this is most likely through the projector's remote control.

d. Camera Focus Page
i. Thumbnail preview of the PTZ camera.
ii. Pan, Tilt, Zoom, and focus controls to set a new focus.
iii. Full Stage preset button
1. This is permanently set to show the entire stage.
iv. Five custom preset buttons than can be touched to recall or touch and hold to store. Provide positive feedback on successful storing of preset. Recalled presets' button should remain highlighted until camera is refocused or another preset is recalled.

e. Help page
i. Contact information for in-house technical support.
ii. Phone and email information for the installing contractor.

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END OF SECTION 27 41 00

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FOR REFERENCE ONLY

SECTION 275116
IP PUBLIC ADRESS 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. 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 Advanced Network Devices (AND). 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. Advanced Network Devices
   2. Authorized Distributor:
      a. Name: Day Automation by Stark Tech.
      b. Contact: Jennifer Fitzsimmons
      c. Email: FitzsimmonsJ@starktech.com

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.
   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.

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 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.

S. 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.

T. 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.

U. 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.

V. 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.

W. 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.

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 annunciate 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.
   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. POE Classroom Clock/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.
9. Advanced Network Devices: IPSWDHD-MW

F. POE Corridor Dual clock/speaker
1. System shall include IP Addressable clock/speaker module.
2. Shall support DHCP.
3. Shall connect to network with a single RJ45 connector.
4. Advanced Network Devices: IPCSHD-DS-MB.

G. POE Ceiling mounted recessed Speakers:
1. System shall include IP Addressable round speaker module.
2. Shall support DHCP.
3. Shall connect to network with a single RJ45 connector.
4. 8" diameter white finish.
5. Advanced Network Devices: IPSCM-RMe.

H. POE Wall surface mounted Speakers:
1. System shall include IP Addressable surface mounted speakers.
2. Shall support DHCP.
3. Shall connect to network with a single RJ45 connector.
4. 8" diameter drive in square steel white enclosure.
5. Advanced Network Devices: IPSWS-SM.

I. POE Exterior surface mounted Speakers:
1. System shall include IP Addressable surface mounted exterior Speaker:
2. Shall support DHCP.
3. Shall connect to network with a single RJ45 connector.
4. Weather resistant IP54 white enclosure.

5. Advanced Network Devices: IPSWS-SM-O.

J. POE Zone Paging Module
   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.

K. 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.

L. 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.

M. 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.

N. 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+

O. 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.

P. 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.

Q. 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.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mounting Heights: Coordinate locations of outlet boxes specified in Section 260533.16 to obtain mounting heights indicated and as indicated on drawings.
   1. Wall-mounted Speaker: As indicated on drawings.
   2. Volume Control Outlets: 48" above finished floor.

C. Splice cable only in accessible junction boxes or at terminal block units.

D. Make cable shields continuous at splices and connect speaker circuit shield to equipment ground only at amplifier.

E. Install input circuits in separate cables and raceways from output circuits.

F. Leave 18 inches excess cable at each termination at microphone, volume pad, speaker, and other system outlet.

G. Leave 6 feet excess cable at each termination at system cabinet

H. Provide protection for exposed cables where subject to damage.

I. Use armored cable for outside speaker circuits.

J. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure for ceiling suspension system. Include bridle rings or drive rings.

K. Use suitable cable fittings and connectors.

L. Connect reproducers to amplifier with matching transformers.

M. Ground and bond equipment and circuits in accordance with Section 260526.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements, for additional requirements.

B. Provide the services of manufacturer's technical representative to prepare and start system.

1. Include making of final wiring connections, inspection and adjusting of completed installation, and systems demonstration.
2. Certify that installation is complete and performs according to specified requirements.

C. Measure and record sound power levels at designated locations.

3.03 ADJUSTING

A. Adjust transformer taps for appropriate sound level.

B. Adjust devices and wall plates to be flush and level.

3.04 CLOSEOUT ACTIVITIES

A. See Section 017900 - Demonstration and Training, for additional requirements.

B. 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.

C. Training: Train Owner's personnel on operation and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

3.05 MAINTENANCE

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

B. Provide service and maintenance of public address and music system for one year from Date of Substantial Completion.

END OF SECTION 275116

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SECTION 275123
PERFORMANCE SOUND SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Gymnasium Sound System equipment.

B. Cable.

1.02 SUBMITTALS

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

B. Shop Drawings: Indicate cable routing and connections.

C. Product Data: For each item of equipment.

D. Manufacturer's Installation Instructions.

E. Project Record Documents: Accurately record actual locations of devices and wiring.

F. Operation Data: Include instructions for routine operation of master and remote stations.

G. Maintenance Data: Include instructions for minor troubleshooting, preventive maintenance, and cleaning.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in installing the products specified in this Section with minimum three years documented experience.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 GYMNASIUM SOUND SYSTEM

A. Manufacturers:
   1. As noted below in components.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Interconnection with IP Clock/PA System: Provide equipment to allow PA system override of local Gymnasium sound system.

2.02 COMPONENTS

A. System components:
   1. 1- Community ALC404D Bi amp, 4-channel.
   2. 4- Community IP-1152/99B Speakers.
   3. 4- Community IUB1152WRG Speaker mounting brackets.
   4. 2000' #16 gauge 2-pair speaker wiring ODS 16/2 CL3. Overall length as required for speaker locations indicated on plans.
   5. 1- Shure SCM262 Mixer.
   6. 2-Shure GLXD124+/85M-Z3 Wireless Microphones.
   7. 1- Shure UA221DB-RSMA Antenna Splitter.
   8. 2- Shure UA850-RSMA Antenna Cable.
   9. 2- Shure PA805D-RSMA Antenna.
   10. 2- Shure UA505-RMSA Mounts.
   11. 1- Tripp Lite DRS-1215 Surge Protector.
   12. 1- Tascam CD-400U Media player CD/SD/USB.

13. 1- Middle Atlantic DWR-12-22PD-12RU Wall Mounted Data Rack.
14. 4-EB1 1RU Blanks.
15. 4- EB2 2RU Blanks.
16. 1-Lock Set.
17. Minimum Controls and Indicators:
    a. POWER ON-OFF selector switch and indicator lamp.
    b. VOLUME control for listen volume level only.

B. Assistive Listening System:
1. A system for broadcasting event content wirelessly for pick-up by hearing impaired attendees shall be provided. This system shall consist of an FM transmitter, portable FM beltpack receivers, and stereo earphones that can be issued to hearing-impaired attendees or anyone wishing to listen to the sound through a personally-worn device.
2. The assistive listening system shall broadcast on the 72-76MHz FM band.
    a. The assistive listening system shall have an opeating range of 1000 ft.
    b. The assistive listening system shall include a total of (2) FM beltpack receivers, each with stereo earphones.
    c. The assistive listening system transmitter shall be a model PPA T45 by Williams Sound or approved equal.
    d. The assistive listening beltpack receivers shall be a model PPA R37 by Williams Sound or approved equal.
    e. Include a plaque for installation at the site advising attendees that assistive listening equipment is available.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as indicated on drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements, for additional requirements.

B. Perform operational test on completed installation to verify proper operation.

C. Replace equipment, components, and wiring to eliminate audible noise, clicks, pops, or hum when system is in standby or operation.

3.04 ADJUSTING

A. Adjust controls and configuration switches for operation as indicated.

3.05 DEMONSTRATION

A. Provide systems demonstration and instructions. Allow minimum of 4 hours.

B. Conduct walking tour of Project and briefly describe function, operation, and maintenance of each component.

C. Use submitted operation and maintenance manual as reference during demonstration and training.

3.06 MAINTENANCE

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

B. Provide service and maintenance for one year from Date of Substantial Completion.

END OF SECTION 275123

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SECTION 280153
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM - Ameican 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, NTRL 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 280153

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FOR REFERENCE ONLY

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 142100 - ELECTRIC TRACTION ELEVATORS: For interface with access control system.

D. Section 260526 - Grounding and Bonding for Electrical Systems.

E. Section 260533.13 - Conduit for Electrical Systems.

F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

G. 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; 2015.

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 manufacturer.

E. Evidence of qualifications for installer.

F. Evidence of qualifications for maintenance contractor (if different entity from installer).

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. Field quality control test reports.

J. Maintenance contracts.

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. Software: One copy of software not resident in read-only memory.

O. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Deliver blank credentials to Owner as directed.

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 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: Avigilon, as indicated under product descriptions below.

B. Access Control Units:
   1. Avigilon.

C. Access Control Software - Avigilon Unity Access 7 Professional

D. Readers:
   1. HID: Signo Readers Model 20.

2.02 ACCESS CONTROL SYSTEM REQUIREMENTS

A. Provide new access control system consisting of required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, work required for a complete operational system that provides the functional intent indicated. Owner to furnish access control reader controllers, REX sensors, and prximity card readers for installation by this contract. Existing system is Avigilon Unity Access 7 Professional.

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.
      b. Proximity Readers:
         1) Utilize 125 kHz RF communication with compatible credentials.
   2. Reader Controllers (Furnished by Owner):
      a. Avigilon LP1501-1 (1) door reader controller.
      b. Avigilon LP1502-2 (2) door access controller.

c. Avigilon LP1508-8 (8) 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) (Furnished by Owner): Passive infrared.
      a. Products:
         1) Bosch DS150i series or equal.
         2) Substitutions: See Section 016000 - Product Requirements.

F. Door Locking Devices (Electric Strikes Locks): This contract to wire completely. Devices and power supplies 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. Unshielded twisted pair (UTP) complying with Section 271000. Cabling as required to an from equipment herein this specification and also noted on drawings.

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) unless exposed in finished spaces, then cables in surface metal raceway.
   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. 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. Prepare and start system in accordance with manufacturer's instructions.

D. Program system parameters according to requirements of Owner.

E. Test for proper interface with other systems.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

G. 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. Instructor: Manufacturer's authorized representative.
   4. 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 access control 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 281000

FOR REFERENCE ONLY

SECTION 281523
INTERCOM ENTRY SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Intercom entry system and associated door/entry stations, interior stations, and accessories.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 087100 - Door Hardware: Electrically operated door hardware, for interface with intercom entry 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 intercom entry system IP network connections.

G. Section 282000 - Video Surveillance System: For interface with intercom entry system.

1.03 REFERENCE STANDARDS

A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of intercom stations with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the work with other installers to provide power for 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 intercom station and equipment locations.
   2. Conduct meeting with facility representative and other related equipment manufacturers to discuss intercom entry system interface requirements.

C. Sequencing:
   1. Do not install intercom stations 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 configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

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.

D. Evidence of qualifications for installer.

E. Specimen Warranty: Submit sample of manufacturer's warranty.

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 certification that products meet or exceed specified requirements.

H. Field quality control test reports.

I. Operation and Maintenance Data: Include detailed information on system operation, equipment setup, replacement parts, and recommended maintenance procedures and intervals.

J. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

K. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. ADA Standards.
   2. NFPA 70 (National Electrical Code).
   3. Applicable TIA/EIA standards.

B. Manufacturer Qualifications: Company engaged in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company with minimum three years documented experience with similar systems and providing contract maintenance service as a regular part of their business; manufacturer's authorized installer.
   1. Contract maintenance office located within 200 miles of project site.

D. Products: Listed, classified, and labeled as suitable for the purpose intended.

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 one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Intercom Entry System:
   1. Aiphone Corporation: www.aiphone.com/#sle.
   2. Alpha Communications: www.alphacommunications.com/#sle.
   3. BEC Integrated Solutions: www.becintegrated.com/#sle.

B. Substitutions: See Section 016000 - Product Requirements.

C. Source Limitations: Furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 INTERCOM ENTRY SYSTEM

A. Provide new intercom entry system consisting of required equipment, conduit, boxes, wiring, connectors, hardware, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description:
   1. System Type: Audio-video, analog.
   2. System Capacity: Equivalent to basis of design.
   3. Interface with Other Systems:
      a. Provide products compatible with other systems requiring interface with intercom entry system.
      b. Interface with electrically operated door hardware as specified in Section 087100.
         1) Capable of locking/unlocking/releasing controlled doors.
      c. Interface with video surveillance system as specified in Section 282000.
         1) Capable of viewing door/entry station cameras from video surveillance system.
         2) Capable of viewing designated video surveillance system cameras from intercom entry system interior stations.

C. Door/Entry Stations:
   1. Vandal resistant, with tamper proof hardware.
   2. Suitable for the environment where installed.
   3. Provide means to initiate call to designated interior station(s).
   4. Provide for hands-free two-way communication with interior station(s).
   5. Audio-Video Door/Entry Station:
      a. Furnished with integral video camera for door/entry monitoring and visitor identification.
      b. Call Initiation: Single button; initiates call to pre-determined interior station(s).
      c. Finish: Stainless steel.
      d. Mounting: As indicated on drawings.
      e. Features:
         1) LED low-light video illumination.
         2) PTZ (Pan/Tilt/Zoom) camera.
         3) Integrated proximity card reader for unlocking/releasing door.
         4) Integrated keypad for access code entry for unlocking/releasing door.

D. Interior Stations:
   1. Audio-Video Master Station:
      a. Provides for hands-free and handset two-way communication with designated door/entry station(s) and other interior station(s).
      b. Provide means for unlocking/releasing door corresponding to door/entry station communication is established with.
      c. Provide means to initiate call with other designated master station(s).
      d. Provide means to initiate call with guard/concierge station(s).
      e. Provide means to initiate video monitoring of connected door/entry station(s).
      f. Mounting: Wall or desk.
      g. Features:
         1) Adjustable audible call notification volume.
         2) Adjustable communication volume.
         3) Adjustable LCD screen brightness.
         4) PTZ (Pan/Tilt/Zoom) camera control.

5) Automatic recording of visitor images upon call initiation from door/entry station.
6) Manual video recording capability.
7) Capability to transfer an answered call to another master station.

2. Audio-Video Guard/Concierge Station:
   a. Provides for hands-free and handset two-way communication with designated door/entry station(s), master station(s), and other guard/concierge station(s).
   b. Provide means for unlocking/releasing door corresponding to door/entry station communication is established with.
   c. Provide means to initiate call with designated door/entry station(s), master station(s), and other guard/concierge station(s).
   d. Provide means to initiate video monitoring of connected door/entry station(s).
   e. Mounting: Wall or desk.
   f. Features:
      1) Adjustable audible call notification volume.
      2) Adjustable communication volume.
      3) Adjustable LCD screen brightness.
      4) PTZ (Pan/Tilt/Zoom) camera control.

E. Accessories:
   1. Provide components as indicated or as required for a complete operating system.
   2. Wiring: Provide manufacturer's recommended cables as indicated or as required for connections between system components.
   3. 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 characteristics 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 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Wiring Method for NFPA 70 Class 2/Class 3 Circuits: Unless otherwise indicated or required by NFPA 70, 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 all cables unless specifically indicated to be exposed.
   7. Cables in the following areas may be exposed, unless otherwise indicated:
      a. Equipment closets.

b. Within joists in areas with no ceiling.

8. 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. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's field reports with submittals.

C. Test to verify wiring is free of shorts and grounds.

D. Prepare and start system in accordance with manufacturer's instructions.

E. Test system for proper operation.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

G. 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 two hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

3.06 PROTECTION

A. Protect installed system components from subsequent construction operations.

END OF SECTION 281523

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FOR REFERENCE ONLY

SECTION 282000
VIDEO SURVEILLANCE SYSTEM

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.

G. Section 281000 - Access Control: For interface with video surveillance system.

1.03 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NECA 303 - Standard for Installing and Maintaining Video Surveillance System; 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 MANUFACTURERS

A. Video Recording and Viewing Equipment - Basis of Design: Avigilon.

B. Substitutions: See Section 016000 - Product Requirements.

2.02 VIDEO SURVEILLANCE SYSTEM

A. Provide new video surveillance system consisting of all required equipment, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

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.
   3. Surge Protection:
      a. Provide surge protection for exterior cameras.
      b. Provide equipment power surge protection where electrical distribution system surge protection is not provided.

C. Video Recording and Viewing Equipment Required:
   1. See article "VIDEO RECORDING AND VIEWING EQUIPMENT" below for product descriptions.

D. Interface with Other Systems:
   1. Provide products compatible with other systems requiring interface with video surveillance system.
   2. Interface with access control system as specified in Section 281000.
      a. Capable of affecting camera/video operation for selected access control system events.

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.

2.03 VIDEO RECORDING AND VIEWING EQUIPMENT

A. Provide new DVR/NVR system recorders and software.

B. Provide additional DVR/NVR recording capacity to accommodate 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:
      a. Basis of Design: Avigilon.
      b. Storage Capacity: As required.
      c. Network: Single 1 Gigabit Ethernet.
      d. Features:
         1) Supports PTZ camera control.
         2) Supports remote access via desktop and mobile device.

D. Software:

1. Unless otherwise indicated, provide all software and licenses required for fully operational system.
2. Video Management System:
   a. Basis of Design: Avigilon Unity Professional 7.

E. Monitors:
1. Unless otherwise indicated, monitors to be provided by Contractor as part of work of this section.

2.04 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 - Avigilon 24C-H5A-3MH (C5)
4. Network (IP Camera - Avigilin 4.0C-H5A-D1 (C2, C3, C7, C12 & C13)
5. Network (IP) Camera - Avigilon 8.0C-H5A-B01 (C1, C4, C6, C9, C10, C11 & C14)
6. Network (IP) Cameras - Avigilon 10.0C-H5DH-DO1-1R (C8).

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.

2.05 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.

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. Prepare and start system in accordance with manufacturer's instructions.

D. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.

E. Program system parameters according to requirements of Owner.

F. Test for proper interface with other systems.

G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

H. 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 one day of training.
   3. Instructor: Manufacturer's authorized representative.
   4. 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. 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. 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 282000

FOR REFERENCE ONLY

SECTION 283111
INTRUSION DETECTION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. System Description
B. Intrusion detection system requirements.
C. Alarm control panel.
D. Keypads.
E. Initiating devices.
F. Alarm notification appliances.
G. Power Supplies.
H. 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; 2015.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
C. UL 609 - Local Burglar Alarm Units and Systems; Current Edition, Including All Revisions.
D. UL 634 - Connectors and Switches for Use with Burglar-Alarm Systems; Current Edition, Including All Revisions.
E. UL 636 - Holdup Alarm Units and Systems; Current Edition, Including All Revisions.
F. UL 639 - Intrusion-Detection Units; Current Edition, Including All Revisions.
G. UL 1610 - Central-Station Burglar-Alarm 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. Coordinate the work with other installers to provide communication lines required for alarm control unit connection to central station.
   4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Preinstallation Meeting: Conduct meeting with facility representative and other related equipment manufacturers to discuss intrusion detection system interface requirements.
C. 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: Manufacturer's data, user and installation manuals for all equipment and software programs including computer equipment and other equipment required for complete Digital Alarm including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

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.
   1. Detailed wiring diagrams and system description.
   2. System device locations on architectural floor plans.
   3. Full Schematic of system, including wiring information for all devices.

D. Design Data: Include standby battery calculations.

E. Certify that proposed system design and components meet or exceed specified requirements.

F. Evidence of qualifications for installer.

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. Field quality control test reports.

J. 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.
   2. Three sets of operating manuals shall be provided explaining the operation and maintenance of the system.
   3. Parts list.
   4. Maintenance required and maintenance schedule.

K. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

L. Maintenance contracts.

M. Project Record Documents: Documentation to be submitted by the Contractor upon completion of system installation:
   1. "As-builts": Upon completion of installation, the Contractor shall prepare "as-built" drawings of the system. These "As-builts" shall be 30 inches by 42 inches (76 cm by 107 cm) format mylar reproducible drawings of each floor plan indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag.
      a. Additionally, final point-to-point wiring diagrams of each type of device (on 30 inches by 42 inches (76 cm by 107 cm) format) shall be included in the "as-builts."
      b. "As-builts" shall be submitted to the Owner for approval prior to the system acceptance walk-through..

N. Software: One copy of software not resident in read-only memory.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualification:
   1. The system shall be the standard product of one manufacturer, and the manufacturer shall have been in business manufacturing similar products for at least 5 years.
   2. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 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.
   1.

D. System Requirements:
   1. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
      a. National Codes: NEC, NFPA, UBC, BOCA, SBCCI, IBC, as applicable.
      b. Approvals and listings: UL, ULC, FM, ANSI SIA CP-01, CSFM, NYC-CoA, as applicable.
      c. Local Authorities Having Jurisdiction (AHJ).

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.

C. Protect store materials from environmental and temperature conditions following manufacturer's instructions.

D. Handle and operate products and systems according to manufacturer's instructions.

1.08 FIELD CONDITIONS

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

B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.09 WARRANTY

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

B. Provide minimum Three year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

C. All components, parts, and assemblies supplied by the manufacturers and installed by the Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.

D. Service/Maintenance:
   1. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).
   2. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.
   3. The installer shall correct any system defect within six hours of receipt of call from the Owner.
   4. Extended service/maintenance agreements shall be offered by the Contractor for up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. A functionally complete, integrated Digital Alarm Communicator System (DACS) per manufacturer's guidelines, codes and specification requirements.
   1. The DACS shall include a Control Panel with built-in Ethernet jack for event communication and remote services.
   2. The DACS shall include a Control Panel with an optional, supervised telephone line interface module.
   3. The DACS shall include recording and retention of event information in a dedicated event log.
   4. The DACS shall incorporate an integral real-time clock, calendar, and a test timer.
   5. The DACS shall incorporate battery charging capabilities with supervision of battery voltage and battery leads.
   6. The DACS shall accommodate a time / event-based scheduling system.
   7. The DACS shall be capable of supervision of peripheral devices and communications interfaces.
   8. The DACS shall accommodate configuration and operation of separate, independent areas.
   9. The DACS shall accommodate hard-wired or wireless point expansion via eight-point interface modules and RF receivers.
   10. The DACS shall accommodate addressable expansion utilizing a 2-wire bus.
   11. DACS incorporate removable terminal strips for wiring connection to facilitate simple service and replacement.
   12. The DACS shall have electrically supervised detection loops and power supplies with battery(s) maintenance. This supervision shall be programmable for the purposes of reporting this information to the DACR.
   13. The DACS shall be capable of sending (manually or automatically) test and status reports to remote DACRs.
   14. The DACS shall be able to accommodate test, diagnostics, and configuration programming functions locally or remotely via a portable programmer or a computer running the Remote Programming Software (RPS).
   15. The DACS shall annunciate alarm, trouble, service reminders, and other relevant system status messages in custom English, Latin American Spanish, Portuguese, Canadian French, Hungarian, Greek, Italian, Polish, German, Dutch, Swedish and/or Chinese text at the ACC.

2.02 INTRUSION DETECTION SYSTEM REQUIREMENTS

A. Provide new intrusion detection system at each building as indicated on plans consisting of all required equipment, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated. System is network based integrated digital alarm communicator system (DACS) per the manufacturers guidelines, codes and specification requirements.

B. Alarm Control Unit: New addressable alarm control panel located as indicated.

C. Combination fire/intrusion systems are not permitted.

D. Keypads: Located as indicated on plans.

E. Initiating Device Requirements:
   1. Protected Premises: Entire building as indicated.
   2. Provide magnetic contacts to monitor opened/closed position for:
      a. All perimeter doors.
      b. All overhead doors.
   3. Provide motion detectors to detect intruder in designated areas.

4. Provide temperature sensors to detect:
   a. Temperatures above selected setpoint for designated freezer/refrigeration units.
5. Provide power loss sensors to detect an extended power failure for:
   a. All freezer/refrigeration units.

F. Alarm Notification and Reporting Requirements:
1. Activate alarm notification at alarm control unit and associated keypads/annunciators with appropriate zone information displayed.
2. Activate local notification appliances.
   a. Interior: Provide siren located as indicated on drawings.
3. Transmit alarm report to listed remote central station under contract with facility.
   a. Primary Communication Means: Internet/intranet (IP addressing).
   b. Secondary Communication Means: Digital cellular communications.

G. Provide products listed, classified, and labeled as suitable for the purpose intended.
1. Local Alarm Units and Systems: Listed and labeled as complying with UL 609.
2. Central Station Alarm Units: Listed and labeled as complying with UL 1610.

H. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.03 ALARM CONTROL PANEL

A. Manufacturers:
1. Addressable Alarm Control Panel - Basis of Design: Bosch Security Systems B9512G.
2. Addressable Alarm Control Panel - Other Acceptable Manufacturers:
   a. Digital Security Controls (DSC); a brand of Tyco International: www.dsc.com/#sle.
   b. Honeywell International, Inc: www.security.honeywell.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.

B. Alarm Control Panel: Modular construction.
1. Enclosure: Lockable; provide tamper protection.
2. Control Panel and Features:
   a. Integrated Conettix IP based communications provides high-speed, secure alarm transport and control.
   b. 32 programmable areas with perimiter and interior partitioning.
   c. 8 onboard. hardwired points with expansion capability for a total of 599 using a combination of wired or wireless points.
   d. Compatibility with Color Graphic Touch Screen, 2-line LCD style Alarm Keypads.
   e. Local or remote programming, test, and diagnostic capability via a computer running the Remote Programming Software (RPS).
   f. The system shall include an integrated USB port for local programming and diagnostics using a computer running Remote Programming Software (RPS) and a male USB2.0 to male USB 2.0 cable with no additional hardware modules required.
   g. The system shall support the use of an Apple iOS device and/or Android device for control. Functions to include arming, disarming and control of outputs and access door, viewing of connected IP cameras. This application shall connect directly to the DACS using internet, wifi or cellular communications and shall not require a third party server of network operations center (noc).
   h. The DACS will allow integration with up to 16 Bosch IP video cameras using the built-in Ethernet connection, allowing the cameras to act as inputs and outputs.
   i. The DACS shall support integration with the Bosch Video Management System (BVMS) using the built-in Ethernet adapter.
   j. The DACS shall support up to thirty-two (32) custom functions allowing the installer to combine up to 6 functions into one command. These custom functions shall be

operated by keypad command, point activation, keyfob button, or programmable schedule.

k. The DACS shall support up to 32 keypad shortcuts which allow the installer to define which commands are available at each keypad.

l. The system shall offer multiple language support that can be assigned per keypad. The system shall offer multiple language support that can be assigned per keypad. Languages supported must include English, Latin American Spanish, Portuguese, Canadian French, Hungarian, Greek, Italian, Polish, German, Dutch, Swedish and/or Chinese.

m. The DACS shall support flash firmware upgrades of systems firmware for the control panel and peripherals, allowing for future updates.

n. Integrated real time clock, calendar, test timer and programmable scheduling capability for relay control and automatic execution of system functions based on a time / event.

o. Provide 1.4 amps of power for standby operation and 2.0 amps of alarm power, both rated at 12 VDC.

p. 3 configurable form ‘C’ wet or dry-contact relay outputs with expansion capability for up to an additional 472 dry-contact relay outputs.

q. Integrated battery charger with reverse hook up protection, battery supervision and battery deep discharge protection.

r. Supervision of peripheral devices and communications interface(s).

3. Point Functionality and Expansion:

a. Each point in the system shall be programmable to provide the following type of response in the system.

1) Always on (24 hour response).
2) On when the system is Master Armed.
3) Only on when the system is Perimeter Armed.
4) Displays / Does Not Display at the ACC when the point is activated.
5) Provides / Does Not Provide entry warning tone.
6) Sounds / Does Not Sound audible alarm indication.
7) The Point is bypassable / not bypassable.
8) Alarm Verification with programmable verification time.
9) Fire Alarm Point.
10) Relay activation by Point.
11) Provides / Does Not Provide "watch point" capability.
12) Provides Swinger Bypass.
13) Defers Bypass Report.
14) Can return to the system after being force armed and then restoring.
15) Can return to the system after being bypassed and then restoring.
16) Keyswitch arming (maintained or momentary)
17) Activate by Custom Function.
18) Activate following an output.
19) Gas Alarm.

b. The system shall support virtual points and outputs for customized programming of events.

c. The DACS shall be capable of supporting "group zoning." Group zoning refers to the combining of points into a separately identifiable and separately annunciated (programmable text) areas.

d. The DACS shall be capable of allowing variable point response times via programming. Point response times shall be programmable over a range of 300 milliseconds to 4.5 seconds.

e. The DACS shall have the capability to expand up to 599 separately identifiable points, of which 8 are on-board and 472 are off-board wired, addressable or wireless points.
   1) The 8 on-board points shall be able to accommodate powered class B functionality using a powered loop interface module.
   2) Point Expansion Modules (Wired and Wireless) shall be able to be located remote to the main panel to a maximum distance of 1000 feet.
   3) Addressable modules shall be able to be located remote to the panel to a maximum of 500 feet.

f. The DACS shall have the capability to expand up to 99 separately identifiable points, of which 8 are on-board and 91 are off-board addressable points connected to multiplexed backbone trunks via wired modules and/or wireless receivers.
   1) The 8 on-board points shall be able to accommodate powered class B functionality using a powered loop interface module.
   2) Point Expansion Modules (Wired and Wireless) shall be able to be located remote to the main panel to a maximum distance of 1000 feet.
   3) Addressable modules shall be able to be located remote to the panel to a maximum of 500 feet.

4. Areas/Accounts
   a. The DACS shall support 32 independent areas. Each of the 32 areas shall have custom text associated with the armed state, disarmed state and point-off-normal state.
   b. The DACS shall be capable of assigning 1 to 4 account identifiers to the areas depending on the distribution of areas per account.
   c. The DACS shall be capable of assigning 1 to 2 account identifiers to the areas depending on the distribution of areas per account.
   d. All of the areas must be capable of Master (All) and/or Perimeter (Part) arming (excluding predefined Interior protection).
   e. The DACS shall be capable of logically grouping 1 or more points into an area, or conversely, dividing 2 or more points into two or more areas.
   f. Any area shall be configurable to allow arming by specific users when a programmable number of devices are faulted or bypassed.
   g. Areas shall be independently controlled by their corresponding ACC.
   h. Area(s) shall accommodate assignment of independent account numbers to define annunciation, control, and reporting functions.
   i. The DACS shall be capable of linking multiple areas to a shared area which may be automatically controlled (hallway or lobby).
   j. The DACS shall accommodate conditional area arming dependant on the state of other areas (master or associate). Any area can be configured for perimeter and interior arming, not requiring a separate area for this function.
5. Output Relay Expansion: The DACS shall provide the capability for output relay expansion using relay expansion modules. Independent control of relay functions by area shall be possible through programming assignments.
   a. The DACS shall be capable of activating 472 additional relay outputs for auxiliary functions based on its classifications (area vs. panel wide). Output Expansion Modules shall be able to be located remote to the main panel to a maximum distance of 1000 feet. 8 relays (Form C) are to be provided per octo-relay module.
   b. The DACS shall be capable of activating 64 additional relay outputs for auxiliary functions based on its classifications (area vs. panel wide). Output Expansion Modules shall be able to be located remote to the main panel to a maximum distance of 1000 feet. 8 relays (Form C) are to be provided per octo-relay module.

c. The DACS shall be capable of controlling relays and automatically executing system functions based on a time / event scheduling program. The program can be hour, day of week or day of month based.
d. Relays and other outputs may be programmed to follow up to 14 different area conditions or up to 12 panel conditions. Relays may also be programmed to follow individual points or groups of points.
e. The DACS shall support 5 different types of alarm output selections: Steady, Pulsed, California Standard, Temporal Code 3 and Temporal Code 4.

6. Scheduling: The DACS shall support scheduling capabilities with the following characteristics:
   a. Arm / Disarm specific area(s) based on open/close windows.
   b. Bypass / Unbypass point(s).
   c. Activate / Deactivate relay(s).
   d. Send test reports.
   e. Up to 4 programmable holiday schedules of 366 days each (includes leap year). Based on the holiday settings, different time windows for open/close and other system functions can be executed.
   f. Automatic adjustment of system clock for daylight savings time.
7. Power Supply:
   a. Primary Power: 120 VAC; provide suitable transformer/power supply; supervised for loss of AC power.
   b. Secondary Power: Standby battery; provide suitable capacity for minimum standby time required by listing requirements, applicable codes, and authority having jurisdiction, but not less than four hours; provide suitable battery charger; supervised for low battery condition; protected from accidental reversal of battery leads.

C. Alarm Initiating Circuits: Supervised.
1. Hardwired Zones: Supports both normally closed and normally open conventional (addressable) initiating devices.
2. Addressable Zones: Supports addressable initiating devices and modules using multiplexed polling loops.

D. Alarm Notification Circuits: Supervised.

E. Communications Interfaces: Supervised.
1. Supports system reporting to central station receivers via integral interface or accessory interface modules using:
   a. Telephone lines.
   b. Digital cellular network.
   c. Internet/intranet (IP addressing).

F. Keypads: Supervised.
1. The DACS shall accommodate connection with up to 32 ACC's, each capable of displaying custom English, Latin American Spanish, Portuguese, Canadian, French, Hungarian, Greek, Italian, Polish, German, Dutch, Swedish and/or Chinese text on liquid crystal display.
2. The Alarm keypads shall accommodate viewing and configuration of system parameters including.
   a. Network Paremeters:
      1) DHCP Enable/Disable for the selected network module.
      2) UPnP Enables/Disable for the selected network module.
      3) IP Address for the selected network module.
      4) Subnet Gateway for the selected network module.
      5) Default Gateway for the selected network module.

6) Port Number for the selected network module - The module's port number shall range from 0 to 65,535.
7) DNS Server Address for the selected modules' DNS server IP address.
8) DNS Host Name for the selected module. The DNS host name shall contain up to 63 characters.
9) AES Encryption Key Size - Enable/Disable encryption by selecting the AES encryption key size for the selected network module.
10) AES Encryption Key String - The user shall be able to display, add and modify the AES encryption string based upon the key size perviously configured for the selected network module.

b. Point Parameters:
1) Point Selection between one and the maximum number of points in the control panel.
2) Point Registration to allow system response from a specific physical point on any one of the expansion modules; On-board or Point expansion modules (wired or wireless).
3) Wireless points shall be able to be enrolled in the system via an auto enrollment feature.

c. Event Routing Parameters to allow programming of up to 4 report routing groups as well as configuration of primary and secondary

G. User Passcodes and Authority: Passcodes shall be programmable with authority levels to allow users to operate any or all areas.
1. Up to 2000 different passcodes shall be accommodated.
2. Up to 500 different passcodes shall be accommodated.
3. Each passcode shall be 3 to 6 digits (variable) and be assigned a 32-character user name.
4. User access to System features and functions shall be configurable based on 14 individually programmable levels of authority assigned to the user passcode. Additionally, the system shall have the capability to assign to the user passcode, a different authority level in each of the areas. A service passcode can be assigned to the servicing agent allowing the agent limited access to system functions. User-programmable / activated functions include:
a. Arming the system: All areas, specific area(s) only, perimeter instant, perimeter delayed, perimeter partial, watch mode, and arming the system with a duress passcode.
b. Disarming the system: All areas, specific area(s) only and disarming with a duress passcode.
c. Viewing system status: Faulted points, event memory, bypassed points, area status and point status.
d. Implementation functions: Bypass a point, unbypass a point, reset sensors, silence bell, activating relays, initiating the remote programming function locally to allow programming the system from a remote location.
e. Testing the system: Local Walk test, Service Walk test, Fire test, send report to remote DACR to check the telephone link, and programming the time and date for the next test report transmission.
f. Change system parameters: ACC display brightness, system time and date, and add/delete/change passcodes.
g. Extend the closing time of the system.
h. Transmitting special alerts and activating audible and visible signals.
i. Executing multiple commands / ACC keystrokes from a single Menu / Command List item. This function shall be able to have a 32 character (alphanumeric) title to identify it on the ACC display.

j. Editing of time / event based scheduling program from the ACC.
k. The DACS shall also provide a "service menu" to implement functions such as viewing and printing the system log, displaying the system firmware revision number, and defaulting (toggling) text displays between custom and default text displays for troubleshooting.

5. The DACS shall allow users to change their own user passcode from the Alarm Keypad (ACC). Managers shall be capable of changing the user passcodes and authority assignments by area of other users from the ACC.
6. The DACS shall incorporate a programmable "Passcode Follows Scope" feature to allow users to arm or disarm only the area they are entering with one simple command or control all areas from one ACC.

H. Communication: The DACS shall be capable of reporting system events and supervisory reports including alarm, trouble, missing modules, restorals, system status, AC failure, battery status to primary and secondary off-site DACR's. The following features shall be supported.
1. The DACS shall be capable of communicating via dial-up analog telephone lines, over a LAN/WAN/Internet using a wired network interface module, or over a cellular network using a CDMA Cellular interface module.
2. The Bosch Modem4 communications format shall be utilized for optimum system performance. The Modem4 format provides the maximum data information to the receiver for alarms, troubles, restorals, bypasses, relay activation, opening/closings, and card access. The detailed information includes the point numbers with text, peripheral device numbers, user numbers with text, and area information. As an alternative format, SIA DC09 or Contact ID may be used although they will include less detailed information like point or user text.
3. The DACS shall be capable of sending text (SMS) messages to compatible devices without requiring that these message are sent to a monitoring center.
4. The DACS shall have the capability of communicating with up to 8 different DACRs using up to 4 different phone numbers, up to 24-digits in length and/or 4 URL/IP addresses over a network.
5. The DACS shall report to a Commercial Central Station that is using a Bosch D6600 Receiver/Gateway or a Bosch D6100i Receiver using Modem4 as a preferred format or Contact ID as an alternate format.
6. The DACR shall provide the transmission information sent from the DACS that includes alarms, troubles, restorals, bypasses, relay activation, opening/closings, and card access. When using the ModemIIIa² format the detailed information includes the point numbers with text, peripheral device numbers, user numbers with text, and area information.
7. The DACS reports shall be classified, by event, into eleven subcategories or "report groups." Each group represents similar types of events. Individual events within each group shall be selectively enabled or disabled for transmission. The eleven report groups shall be as follows:
a. Fire Reports.
b. Burglar Reports.
c. User Reports.
d. Test Reports.
e. Diagnostic Reports.
f. Relay Reports.
g. Auto Function Reports.
h. RPS Reports.
i. Point Reports.
j. User Change Reports.
k. Access Reports.

8. The DACS shall have the capability to verify the integrity of the remote communications path and switch to alternate paths when a communications failure occurs.
9. The DACS shall be capable of unattended mode of operation whereby programming and configuration updates are automatically transferred using the Remote Programming Software (RPS). These updates can initiate from either the control panel or the remote computer using RPS.

I. Network Communication: The DACS shall be capable of network communications over a LAN, WAN, Intranet, or the Internet. The system shall include supervision of the network communication utilizing configurable periodic heartbeats to the Digital Alarm Communications Receiver (DACR). The DACR shall provide notification of the loss of communications from a networked system after a programmable timeframe since the last communication. The notification options shall be programmable and include local annunciation or indication to automation software.
   1. The network interface module shall be capable of supporting Dynamic Host Communication Protocol (DHCP) to obtain an IP Address.
   2. The system shall support a method of authentication between the control panel and the receiver to ensure that the control panel has not been compromised or replaced.
   3. The network interface modules shall be capable of supporting encryption using a minimum of 256-bit AES Encryption (Rijndael) certified by NIST (National Institute of Standards and Technology) utilizing the Cipher Block Chaining (CBC) method.
   4. The network interface module shall support a 10/100BaseT connection to an Ethernet network.
   5. The control panel shall be capable of network communication with a programmable poll time to send periodic heartbeats to the receiver, programmable ACK Wait time, and programmable retry time. In the situation where a communication path is unsuccessful, the control panel shall be capable of attempting backup communication through an available communication method to the same receiver or a backup receiver.
      a. The control panel shall have the ability to automatically adjust the heartbeat rate of a backup path that is using cellular to the heartbeat rate of the primary path in case of a primary path failure. Upon restoral of the primary path, the heartbeat rate of the backup path shall automatically restore to the original rate. This allows a system utilizing cellular communications to keep the wireless charges low.
      b. The network communication between the control panel and the receiver shall use Modem4, SIA DC09 or Contact ID.
      c. The control panel shall be capable of two-way communication using a wired network interface module with a 10/100BaseT on a LAN/WAN/Internet configuration or with a cellular module on the Internet.
      d. The control panel shall be capable of configuring the destination of the receiver using a URL or static IP Address.
      e. The control panel shall be capable of using DNS to lookup the IP Address of the receiver when programmed with a URL.
      f. The control panel shall support UPnP for automated Port Forward configuration in the router where the control panel is installed.
      g. The control panel shall support AutoIP to enable the RPS software to connect to the control panel locally using an IP Direct connection.
      h. The control panel shall support configuration of the IP parameters from the keypad eliminating the need for a PC to configure the IP device.
      i. The control panel shall support network diagnostics from a keypad to allow local testing of network connectivity. The diagnostics should include, Ethernet cable connected, gateway configuration ok, DNS lookup operational, and external network connectivity (such as the Internet) operational.
      j. The system shall be capable of meeting DCID 6/9 and UL 2050 standards.

J. Event Log: The DACS shall maintain a log of events indicating time, day, month, year type of event, account number, area number, user ID, point text, user text and primary/secondary event route. The system shall allow the following characteristics:
   1. The DACS shall be capable of storing up to 10,000 events.
   2. The DACS shall support viewing of logs locally at the ACC and remotely via an upload to a remote central station computer running the RPS software.
   3. The DACS shall provide notification via a report to the DACR when the event log reaches a programmable “percent full capacity". This allows retrieval of stored events via RPS to prevent any loss of event history.
   4. Group, signal type and area can route events to specific receivers.
   5. Each DACR shall be designated as a primary, backup, or duplicate destination for each report group. Assigning an event to multiple routing groups provides for duplicate destinations for the event. The transmission of grouped events allows the reporting of different types of information to different remote DACRs.

K. Testing, Diagnostic, and Programming Facilities: The DACS shall be capable of sending (manually or automatically) test and status reports to remote DACRs.
   1. The DACS shall be capable of sending automatic tests daily, weekly or once every 28 days. Automatic test times shall be programmable to provide an offset of up to 24 hours from the current time.
   2. Automatic test reports shall be programmable to be deferred by one test interval if any other report is transmitted in the current interval.
   3. Automatic test reports and remote system access for diagnostics shall be supported via a remote central station computer with Remote Programming Software (RPS).
   4. The DACS shall be programmable locally or remotely. Programming shall be accomplished via a Keypad or a computer with a remote programmer and diagnostic software package (RPS).
   5. The DACS shall allow an on-site user to initiate remote programming while on-line with the servicing location. The remote programming device must provide a compare feature and allow for downloading either the stored program or the (un)modified program copied from the panel.
   6. The DACS shall allow the local programming option to be disabled and must provide a method to program a panel while no one is on premises, when the panel shares a line with an answering machine.
   7. The DACS shall accommodate IP Diagnostic to verify settings and operation of the network interface modules; Host name, MAC address, IPV4 address assignment. The IP Connection test shall include; Link test to verify physical cable integrity, Ping test to verify gateway response, ping test to verify address on the internet.
   8. Wireless point diagnostics shall include signal strength and device states of registered wireless points in the system.
   9. The number of system testing and programming sessions shall be restricted via the use of program locking features and passwords. Passcode protection in excess of sixteen million combinations is required.
   10. New modules support enhanced diagnostics through RPS.

L. Miscellaneous Features: Programmable alarm output timer, 4 programmable entry delay times, exit delay programmable by area, individually programmable point of protection text, point bypassing, key switch arming capability with LED outputs, and fire verification.

M. False Alarm Reduction: The DACS shall comply with all ANSI SIA CP-01 2010 requirements for false alarm reduction.

N. Ambush Detection: The DACS shall include an early ambush feature that requires that the user disarm, and then inspect the facility within a specified time period, before entering their passcode or a different authorized passcode again. If the user does not enter a passcode a

second time, a duress event is generated. If the user does enter a passcode within the specified time period, the system disarms.

O. Two man rule: The DACS shall include a programmable feature that requires 2 separate passcodes to be entered to disarm the system. After 1 passcode is entered, the system will prompt for a second passcode to be entered on the same ACC. Without the second passcode, the system shall not disarm.

P. Dual Authentication: The DACS shall support Dual Authentication by area. Areas programmed for Dual Authentication require activate of a card and a passcode to allow access to system functions, arm/disarm, or access control doors.

Q. Area Re-Arm: The System shall support programmable area re-arm time of 1 minute to 24 hour.

R. User-Programmable Features: The DACS shall provide a menu driven interface to provide a user-friendly command structure for programming / customizing the system to the operational criteria of the application. The DACS shall be capable of being operated via:
   1. The Command Structure.
   2. Menu / Command List.

S. Peripheral Devices: Supervised; provide tamper protection.

T. Output Relays:
   1. Relay Modules: Form C relays (normally open and normally closed); provide tamper protection.
   2. Programmable to respond to system events, according to defined scheduling, or by manual activation from keypad.

U. User Codes:
   1. Each user code to be individually assignable to any defined authority level for configurable access to system features and functions.

V. Partitions:
   1. Each partition to operate independently with individually programmable annunciation, control, and reporting functions.
   2. Each zone to be individually assignable to any partition.
   3. Each keypad to be individually assignable to any partition.
   4. Each output relay to be individually assignable to any partition.
   5. Each user code to be individually assignable to any partition.

W. Scheduling:
   1. Provide time/calendar-based scheduling capability for automated system control.
   2. Supports open/close schedules for control of arming/disarming and reporting.
   3. Supports timed events including, but not limited to:
      a. Point bypass/unbypass.
      b. Relay activate/deactivate.

X. Event Log:
   1. Stores system events including time, date, partition, zone, and user code where applicable.
   2. Supports viewing of event log on keypads.
   3. Supports viewing of event log on remote PC.
   4. Minimum Number of Events Stored: Equivalent to basis of design.

Y. Features:
   1. Capable of being programmed locally or remotely.
   2. Supports user interface via:
      a. Telephone.

b. Web browser.
c. Mobile device.
d. Personal wireless device.

2.04 SYSTEM INTERFACE REQUIREMENTS

A. Grounding: The Contractor shall properly earth ground the DACS to prevent electrostatic charges and other transient electrical surges from damaging the DACS panel.

B. Primary power: The Contractor shall provide a dedicated 120 VAC power circuit to the DACS system. This circuit shall be connected to the emergency power system. The 120 VAC is stepped down to power the DACS panel using a class two, plug-in transformer. This power circuit shall be properly rated to continuously power all points and functions indefinitely in full alarm condition.\

C. Primary power supervision: When the primary power source fails, the system can be configured to report an "AC Fail" message to a commercial central station.
1. The message can also be programmed to "tag-along" with another message transmitted to the central station.
2. The system will always display a loss of primary power on the ACC and may be configured to provide additional audible warning.
3. The transmission delay of this message is programmable from 5 seconds to 86 minutes with an optional 6 to 12 hour transmission delay

D. Secondary power (standby battery): The Contractor shall provide adequate battery power as defined by the relevant application criteria, (UL 864 and UL 985 for alarm installations or NFPA 72 chapters for fire applications). Appropriate battery chargers shall be provided consistent with the battery back-up capacity. The most current accepted version of NFPA 72 and any applicable local codes or AHJ requirements must be met accordingly.

E. Secondary power supervision: When the secondary power source experiences a 85 percent depletion of its standby capacity, the system can be configured to report a "Low Battery" message to a commercial central station. The system will always display a low battery condition on the ACC and may be configured to provide additional audible warning.

F. Telephone interface: The control panel in the DACS shall be equipped with an optional phone line monitor and shall interface with the phone lines via RJ-31X jacks for supervision of the telephone line connection.
1. The telephone line interface shall conform with FCC rules (Title 47 C.F.R. part 68).
2. When a telephone line is determined to be out of service by the DACS panel, the event will be annunciated locally on the ACC and transmitted to the central station over the alternate communications interface. The transmission delay of this message is programmable from ten to two-hundred forty seconds.

G. Ethernet Interface: The DACS shall include a integrated Ethernet interface module as the primary, or back-up means of communicating to a DACR.
1. Built-in IP-based alarm transport, programming, and control.
2. The module shall accommodate 128 and 256-bit AES encryption using CBC (Cipher Block Chaining) mode.
3. 10BASE T or 100BASE T network connection.
4. Full-duplex and half-duplex support.

H. Cellular interface: The DACS may use a cellular radio module as the primary, or backup, means of communicating to a DACR. Up to 4 IP Addresses shall be available for routing system events. The supervision time shall be programmable with a range of 5 to 65,535 seconds. The module shall accommodate 128 and 256-bit AES encryption using CBC (Cipher Block Chaining) mode.

I. Auxiliary function control interfaces: The DACS shall accommodate auxiliary functions such as activating bells, strobes, or lights and shall be accomplished using the optional application specific relay modules. These auxiliary interfaces shall be electrically isolated to avoid inter-system interferences or damage to the system.

J. Wiring: The contractor shall provide cables consistent with the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
   1. Wiring shall be appropriately color-coded with permanent wire markers. Copper conductors shall be used.
   2. All signal cables provided under this contract shall be Class II, plenum-rated cable where required. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.
   3. Data wires shall not be enclosed in conduit or raceways containing AC power wires.
   4. Where EMI may interfere with the proper operation of the DACS circuits, twisted/shielded cable shall be used.

K. Environmental Conditions: The DACS shall be designed to meet the following environmental conditions:
   1. The system shall be designed for a storage temperature of -10° C to 70°C (14° F to 158°F).
   2. The system shall be designed for an operating temperature of 0° C to 50°C (32° F to 120°F).
   3. The system shall be designed for normal operation in an 85% relative humidity environment.
   4. The system shall meet or exceed the requirements of FCC rules Title 47 C.F.R. Part 15, Class B devices, and Part 68, IEC EMC directive.
   5.

2.05 KEYPADS

A. Manufacturer: Same as manufacturer of 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. Keypad Type: Only graphic touch screen keypads are acceptable. Do not use LED or LCD keypads.

F. Graphic Touch Screen Keypads: Displays system status and zone information using plain English on graphic display; touch screen interface.

G. Keypad Color: White unless otherwise indicated.

H. Basis of Design Products:
   1. Bosch B942 Touch Screen Keypad.

2.06 INITIATING DEVICES

A. Manufacturers: Same as 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. Door 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.
      a. Use standard security contacts (not balanced magnetic type) unless otherwise indicated.
      b. Integral wiring pigtail for building frame side.
   3. Contact Color: Metal Aluminum.
   4. Basis of Design Products:
      a. Bosch ISN-CMET-200AR Standard doors.
      b. Bosch ISCN-CMET-4418 Overhead doors.

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).
   3. Basis of Design Products:
      a. Bosch Commercial Series Gen2 TriTech Motion Sensors - Wall mounted White.
      b. Bosch DS9370 Series Panoramic (360 Degree) TriTech Motion Sensor - Ceiling Mounted White.

E. Hold-Up/Panic Switches:
   1. Listed and labeled as complying with UL 634 or UL 636 as applicable.
   2. Hold-Up/Panic Buttons: Manual push button operation.

F. Temperature Sensors:
   1. Designed to activate upon detecting temperatures above or below selected setpoints.

G. Power Loss Sensors:
   1. Designed to activate upon detecting loss of power.

2.07 ALARM NOTIFICATION APPLIANCES

A. Manufacturers: Same as manufacturer of alarm control units where possible.

B. Provide alarm notification appliances suitable for connection to control unit outputs.

C. Sirens: Speaker with self-contained siren driver and top mounted strobe.
   1. Minimum Sound Output:
      a. Indoor Units: 100 dB at 3 feet (1 m).
   2. Strobes:
      a. Color: Red.

2.08 ACCESSORIES

A. Provide components as indicated or as required for connection of alarm control unit to devices and other systems indicated.

B. Provide wireless receivers and repeaters as indicated or as required for communication between wireless devices and alarm control unit; provide tamper protection.

C. Provide cables as indicated or as required for connections between system components.

D. Provide end-of-line resistors (EOLR) as required for supervision of hardwired zones.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive devices and notify adverse conditions affecting installation or subsequent operation.

B. Do not begin installation until unacceptable conditions are corrected.

C. If preparation is the responsibility of another installer, notify architect of unsatisfactory preparation before proceeding.

D. Ensure selected location is secure and offers protection from accidental damage.

E. Location shall provide reasonable temperature and humidity conditions, free from sources of electrical and electromagnetic interference.

F. Ensure power source is protected against accidental shutoff.

G. Install all equipment and materials in accordance with the "current" recommendations of the manufacturer. The work shall also be in accordance with:
   1. Installation criteria defined in these specifications and in the construction documents.
   2. Factory Representative can be the Bosch Security Systems Inc Security Dealer.
   3. Approved submittals.
   4. Applicable requirements of referenced standards.

H. The contractor shall provide the following services as part of the contract:
   1. Supervision of sub-contractors.
   2. Coordination of other contractors for system-related work (electrical contractor, finish hardware contractor, architect, and general contractor).
   3. Attending site construction/coordination meetings.
   4. Keeping updated construction drawings at the construction site.
   5. Meeting construction deadlines per the construction schedule.

I. Programming of the system shall include the following tasks:
   1. Programming system configuration parameters (hardware and software, zone/circuit numbers, communication parameters).
   2. Programming operational parameters such as opening/closing reports and windows, system response text (custom English) displays of events, activation of relays that drive auxiliary devices, and identifying types of zones/loops.
   3. Programming passcodes according to the authorities and functions defined by the owner.
   4. Other system programming tasks required by the owner. These additional programming requirements shall be coordinated between the owner and the contractor.
   5. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.
   6. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.
   7. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk-through.
   8. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer's performance allowance/margin, a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.
   9. Fire Alarm Systems shall comply with NFPA 72 Standards for inspection, testing, and maintenance.

J. The contractor shall certify completion in writing and schedule the commissioning walk-through. The contractor shall provide all the tools and personnel needed to conduct an efficient commissioning process.

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. Install wiring in conduit where required for rough-in, where required by authority having jurisdiction, and where exposed to damage.
   3. Conduit: Comply with Section 260533.13.
   4. Conceal all cables unless specifically indicated to be exposed.
   5. Cables in the following areas may be exposed, unless otherwise indicated:
      a. Equipment closets.
   6. 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. Installation contractor shall submit a written test report that the system has been 100 percent tested and approved. Final test shall be witnessed by the owner, engineer, electrical contractor, chief security officer, and performed by the installation contractor. Final test report shall be received and acknowledged by the owner prior to request for final payment.

C. Provide instruction to the owner's satisfaction with regard to proper use and operation of the system.

D. Determine and report all problems to the manufacturer's customer service department.

E. 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 alarm notification appliances.
   3. Test for proper operation of output relays.
   4. Test for proper operation of communication interfaces and central station reporting.

F. 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.

B. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).

C. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.

D. The installer shall correct any system defect within six hours of receipt of call from the Owner.

3.05 DEMONSTRATION

A. Demonstrate at final inspection that surveillance system and devices functions properly.
   1. The Contractor upon completion of installation shall furnish training in the complete operation of the systems.

3.06 CLEANING

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

3.07 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

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 one day of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site. Coordinate personel from all buildings at one time.

3.08 TRAINING

A. Train owner's personel on system software operation and functions not limited to the following:
   1. Provide (36) hours of owner on-site training in field, demonstrating system features, functions, arming/disarming.
   2. Train owner's personel on remote system software of relevant system functions and programming.
   3. Provide walkthorugh at each building with owners presonel showing system devices, keypad locations and general equipment of the system.
   4. Provide a total of (2) call-back on-site training total of (4) hours each block.

3.09 PROTECTION

A. Protect installed system components from subsequent construction operations.

B. Touch-up, repair or replace damaged products before substantial completion.

3.10 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 283111

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FOR REFERENCE ONLY

SECTION 283210
AUTOMATED LOCKDOWN SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Alarm control unit.

B. Keypads.

C. Initiating devices.

D. Alarm notification appliances.

E. 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.

E. Section 275116 IP Public Address and Clock System

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 609 - Local Burglar Alarm Units and Systems; 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. Coordinate the work with other installers to provide communication lines required for alarm control unit connection to central station.
   4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Conduct meeting with facility representative and other related equipment manufacturers to discuss intrusion detection system interface requirements.

C. 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. 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. 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.

L. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

M. Maintenance contracts.

N. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

O. Software: One copy of software not resident in read-only memory.

P. 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. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. 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.

E. Maintenance Contractor Qualifications: Same entity as installer.

F. 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 new lockdown 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. Provide equipment, connections and programming to interupt auditorium lighting system to 100% house lighting output in the event of lockdown system initation.

C. Alarm Control Unit: New addressable alarm control panel located as indicated.

D. Initiating Device Requirements:
   1. Protected Premises: Entire building as indicated.

E. Alarm Notification and Reporting Requirements:
   1. Activate alarm notification at alarm control unit and associated keypads/annunciators with appropriate zone information displayed.
   2. Activate local notification appliances.
      a. Interior: Provide siren located as indicated on drawings.
      b. Exterior: Provide siren and strobe located as indicated on drawings.
   3. Transmit alarm report to listed remote central station under contract with facility.
      a. Primary Communication Means: Telephone line (digital alarm communicator).
      b. Secondary Communication Means: Internet/intranet (IP addressing).

F. Interface with Other Systems:
   1. Provide products compatible with other systems requiring interface with IP clock/PA system.

G. Provide products listed, classified, and labeled as suitable for the purpose intended.
   1. Local Alarm Units and Systems: Listed and labeled as complying with UL 609.
   2. Central Station Alarm Units: Listed and labeled as complying with UL 1610.
   3. Proprietary Alarm Units and Systems: Listed and labeled as complying with UL 1076.
   4. Police Station Connected Alarm Units and Systems: Listed and labeled as complying with UL 365.

H. 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. Addressable Alarm Control Panel - Basis of Design: Bosch B9512G.
   2. Addressable Alarm Control Panel:
      a. Bosch Security Systems; (Basis of Design): www.boschsecurity.us/#sle.
      b. Digital Security Controls (DSC); a brand of Tyco International: www.dsc.com/#sle.
      c. Honeywell International, Inc: www.security.honeywell.com/#sle.
   3. Substitutions: See Section 016000 - Product Requirements.
   4. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer.

B. Alarm Control Panel: Modular construction.
   1. Enclosure: Lockable; provide tamper protection.
   2. Power Supply:
      a. Primary Power: 120 VAC; provide suitable transformer/power supply; supervised for loss of AC power.

b. Secondary Power: Standby battery; provide suitable capacity for minimum standby time required by listing requirements, applicable codes, and authority having jurisdiction, but not less than four hours; provide suitable battery charger; supervised for low battery condition; protected from accidental reversal of battery leads.

C. 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.

D. Alarm Notification Circuits: Supervised.

E. Communications Interfaces: Supervised.
1. Supports system reporting to central station receivers via integral interface or accessory interface modules using:
a. Digital cellular network.
b. Internet/intranet (IP addressing).

F. Keypads: Supervised.
1. Minimum Number of Keypads Supported: Equivalent to basis of design.

G. Peripheral Devices: Supervised; provide tamper protection.

H. Output Relays:
1. Relay Modules: Form C relays (normally open and normally closed); provide tamper protection.
2. Programmable to respond to system events, according to defined scheduling, or by manual activation from keypad.
3. Minimum Number of Output Relays Supported: Equivalent to basis of design.

I. User Codes:
1. Each user code to be individually assignable to any defined authority level for configurable access to system features and functions.

J. Event Log:
1. Stores system events including time, date, partition, zone, and user code where applicable.
2. Supports viewing of event log on keypads.
3. Supports viewing of event log on remote PC.
4. Supports printing of event logs on local printer.
5. Minimum Number of Events Stored: Equivalent to basis of design.

K. Features:
1. Capable of being programmed locally or remotely.
2. Supports panic/duress codes.
3. Supports user interface via:
a. Web browser.
b. Mobile device.
c. Personal wireless device.

2.03 KEYPADS

A. Manufacturer: Same as manufacturer of 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. Graphic Slim Touch Screen Keypads: Displays system status and zone information using plain English on graphic display; touch screen interface.

F. Basis of Design Products:
   1. B940W Slim Touch Keypad.

2.04 INITIATING DEVICES

A. Manufacturers: Same as 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. Hold-Up/Panic Switches:
   1. Listed and labeled as complying with UL 634 or UL 636 as applicable.
   2. Hold-Up/Panic Buttons: Manual push button operation.
   3. Basis of Design Products:
      a. STI Stopper Lockdown pushbutton.

2.05 ALARM NOTIFICATION APPLIANCES

A. Manufacturers: Same as manufacturer of alarm control units where possible.

B. Provide alarm notification appliances suitable for connection to control unit outputs.

C. Outdoor Units: Weather resistant, suitable for outdoor use.

D. Sirens: Speaker with self-contained siren driver.
   1. Minimum Sound Output:
      a. Indoor Units: 100 dB at 3 feet (1 m).
      b. Outdoor Units: 110 dB at 3 feet (1 m).

E. Strobes:
   1. Color: Blue.

F. Basis of Design Products:
   1. Algo .

2.06 ACCESSORIES

A. Provide components as indicated or as required for connection of alarm control unit to devices and other systems indicated.

B. Provide wireless receivers and repeaters as indicated or as required for communication between wireless devices and alarm control unit; provide tamper protection.

C. Provide cables as indicated or as required for connections between system components.

D. 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. Install wiring in conduit where required for rough-in, where required by authority having jurisdiction, and where exposed to damage.
   3. Conduit: Comply with Section 260533.13.
   4. Conceal all cables unless specifically indicated to be exposed.
   5. Cables in the following areas may be exposed, unless otherwise indicated:
      a. Equipment closets.
      b. Within joists in areas with no ceiling.
   6. 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. 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. Prepare and start system in accordance with manufacturer's instructions.

D. Inspection and testing to include, at a minimum:
   1. Test each initiating device for proper response by alarm control unit.
      a. Test glass break detectors using only manufacturer's recommended glass break simulation test units.
   2. Test for proper operation of alarm notification appliances.
   3. Test for proper operation of output relays.
   4. Test for proper operation of communication interfaces and central station reporting.
   5. 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 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. 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. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

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. 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. 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 283210

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SECTION 284600
FIRE DETECTION AND ALARM - NOTIFIER ONYX (FIRE COMMAND SYSTEMS)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire alarm system requirements.

B. Fire alarm control panels and accessory equipment.

C. Fire alarm system initiating devices.

D. Fire alarm system notification appliances.

E. Fire alarm system accessories.

F. Single- and multiple-station alarms.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 142100 - ELECTRIC TRACTION ELEVATORS: For interface with fire alarm system.

C. Section 233300 - Air Duct Accessories: Smoke/fire dampers for interface with fire alarm system.

D. Section 260526 - Grounding and Bonding for Electrical Systems.

E. Section 260533.13 - Conduit for Electrical Systems.

F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

C. NFPA 76 - Standard for the Fire Protection of Telecommunications Facilities; 2020.

D. UL 38 - Standard for Manual Signaling Boxes for Fire Alarm Systems; Current Edition, Including All Revisions.

E. UL 217 - Standard for Smoke Alarms; Current Edition, Including All Revisions.

F. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems; Current Edition, Including All Revisions.

G. UL 268A - Standard for Smoke Detectors for Duct Application; Current Edition, Including All Revisions.

H. UL 464 - Standard for Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories; Current Edition, Including All Revisions.

I. UL 521 - Standard for Heat Detectors for Fire Protective Signaling Systems; Current Edition, Including All Revisions.

J. UL 539 - Standard for Single and Multiple Station Heat Alarms; Current Edition, Including All Revisions.

K. UL 864 - Control Units and Accessories for Fire Alarm Systems; Current Edition, Including All Revisions.

L. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

M. UL 1480 - Standard for Speakers for Fire Alarm and Signaling Systems, Including Accessories; Current Edition, Including All Revisions.

N. UL 1638 - Standard for Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories; Current Edition, Including All Revisions.

O. UL 1971 - Standard for Signaling Devices for the Hearing Impaired; Current Edition, Including All Revisions.

P. UL 2034 - Standard for Single and Multiple Station Carbon Monoxide Alarms; Current Edition, Including All Revisions.

Q. UL 2075 - Standard for Gas and Vapor Detectors and Sensors; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
2. Coordinate the placement of devices with potential conflicts and/or view obstructions installed under other sections or by others.
3. Coordinate the work with other installers to provide power for equipment at required locations.
4. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:
1. Conduct meeting with facility representative to review device and equipment locations.
2. Conduct meeting with facility representative and other related equipment manufacturers to discuss fire alarm system interface requirements.

C. Sequencing:
1. Do not install devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

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

B. Submittal Documents:
1. Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
2. Comply with 780 CMR Chapter 9, section 902.2.1 requirements for Tier One Construction Documents.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

D. Shop Drawings:
1. Comply with 780 CMR Chapter 9 requirements for Tier Two Shop Drawings.
2. Include plan views indicating locations of system components.
3. Include elevations and details of proposed equipment arrangements.
4. Include system interconnection schematic riser diagram that shows proposed and approved cable size and type.
5. Include requirements for interface with other systems.
6. Indicate system zone boundaries.
7. Include sequence of operation with input/output matrix as provided in Tier One Construction Documents.
8. Graphic Annunciators: Include proof for approval prior to fabrication.

E. Circuit Calculations:

1. Notification appliance circuit ampacity and voltage drop calculations.
2. Emergency Voice/Alarm Communication Systems (EVACS): Include speaker circuit audio loss calculations.
3. Standby battery calculations.
4. Spare capacity calculations.

F. Manufacturer's certification that products meet or exceed specified requirements.

G. Manufacturer's equipment seismic qualification certification.

H. Specimen Warranty: Submit sample of manufacturer's warranty.

I. Evidence of installer name and state license number with expiration date.

J. 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.

K. Inspection and Test Reports:
1. Installer to submit inspection and test plan prior to closeout demonstration.
2. Installer to submit NFPA 72 "Record of Inspection and Testing" forms, filled out by installer.

L. Installer to submit NFPA 72 "Record of Completion" forms, filled out completely by installer and signed by Owner and authorized representative of authorities having jurisdiction.

M. Operation and Maintenance Data:
1. Include detailed information on system operation, equipment programming and setup.
2. Include manufacturer's preventive maintenance recommendations.
3. Other data as defined in NFPA 72 section 14.3.1 and 14.4.3.2, with any variations noted by design professional as required by 780 CMR 901.2.1 (1) (a) (iii).
4. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

N. Executed Warranty: Submit documentation of final executed product warranties completed in Owner's name and registered with manufacturer.

O. Maintenance contracts.

P. Project Record Documents:
1. Comply with 780 CMR Chapter 9 requirements for Tier Three Record Drawings.
2. Installer to record actual locations of system components and installed wiring arrangements and routing. Indicate final device and terminal identifications.
3. Indicate actual programmed operating sequences, including control events by device, updated input/output matrix, and voice messages by event or printed copy of program.
4. Place in as-built documents cabinet(s).

Q. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Spot-Type Detectors: Five percent of total quantity installed for each type, but not less than one of each type supplied.
3. Extra Notification Appliances: Five percent of total quantity installed for each type, but not less than one of each type supplied.
4. Extra Addressable Modules: One of each type supplied.
5. Software: One copy of software not resident in read-only memory.

1.06 QUALITY ASSURANCE

A. Comply with the following:
1. Requirements of local authorities having jurisdiction.

2. Applicable local codes.
3. NFPA 72.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
1. Authorized support facilities located within 50 miles of project site.

D. Installer Qualifications:
1. Company with minimum three years documented experience with similar fire alarm systems and providing contract maintenance service as a regular part of their business.
2. Familiar with products to be installed through documented manufacturer training, authorization, or equivalent demonstrated experience.
a. Notifier Basis of Design System: Specialized training as provided by Notifier Premier representative.
3. Installer Personnel: At least three years experience installing fire alarm systems.
4. Supervisor: State licensed and NICET Level III or IV certified fire alarm technician.
5. Licensed electrical or systems contractor in the State in which the Project is located.

E. Maintenance Contractor Qualifications: Same entity as installer.

F. Products: Listed, classified, and labeled as suitable for the purpose intended.

G. 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 three year manufacturer warranty for fire alarm control panels and accessories covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Alarm Control Panels and Accessory Equipment - Basis of Design: Notifier ONYX Series by Honeywell as indicated under product descriptions below; www.securityandfire.honeywell.com/notifier/en-us/#sle.

B. Substitutions: See Section 016000 - Product Requirements.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

D. Source Limitations: Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.

E. Suppliers:
1. Notifier Basis of Design System: Fire Command Systems, Inc; 7 Eustis Street, Unit B, Saugus, MA 01906; (978) 401-9840; www.firecommandsystems.com.

2.02 FIRE ALARM SYSTEM REQUIREMENTS

A. Provide new fire alarm 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. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries with capacity to operate system for period specified by NFPA 72.
a. Systems With Voice (EVACS): 24 hours standby time with 15 minutes of alarm.

C. Spare Capacity:
1. Signaling Line Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Speaker Amplifiers: Minimum 25 percent spare capacity.

D. Exterior Notification:
1. In addition to required occupant notification, provide notification on exterior of building as follows:
a. Sprinkler System Waterflow Visible Notification: Provide strobe beacon (Edwards Signaling Model 125STRN*1248DB) with clear lens; interface to dedicated notification appliance circuit or control module (Notifier Model FCM-1), 24 VDC, supervised; same circuit as sprinkler system waterflow audible notification where provided.
b. Sprinkler System Waterflow Audible Notification: Provide bell (Notifier Model SSM24-6); interface to dedicated notification appliance circuit or control module (Notifier Model FCM-1), 24 VDC, supervised; same circuit as sprinkler system waterflow visible notification where provided.

E. Wiring Methods:
1. Comply with 527 CMR 12.00 (Massachusetts Electrical Code).
2. Pathway class designations and pathway survivability are as defined in NFPA 72.
3. Pathway Class Designations:
a. Unless otherwise indicated or required, pathways to meet the following requirements:
1) Signaling Line Circuits (SLC): Class B (star, tee-tap, multi-tap, with no return).
2) Initiating Device Circuits (IDC): Class B (daisy-chain with end-of-line resistor device installed at end of circuit).
3) Notification Appliance Circuits (NAC): Class B (daisy-chain with end-of-line resistor device installed at end of circuit).
4) Network Communications: Class B.
5) Other Wiring:
(a) Other life safety control features not covered above (e.g. door holder circuits, elevator recall circuits, fire smoke dampers, air handling system interfaces, etc) to be wired as Class D (failsafe, where the intended operation is performed in the event of a pathway failure).

(b) Where Class D wiring is not possible due to limitation of equipment, wiring to be limited to 3 feet between control module and equipment and be installed in metal conduit.

4. Pathway Survivability:
   a. Unless otherwise indicated or required, pathways to meet requirements for Pathway Survivability Level 0 (non-rated cable, no required provisions for pathway survivability).
      1) Exceptions:
         (a) For voice evacuation (EVACS) systems employing relocation or partial evacuation, pathways for notification and communication circuits and other circuits necessary to ensure continued operation of emergency communication system to meet requirements for Pathway Survivability Level 3 (rated cable, building protected by automatic sprinkler system).

F. Fire Alarm System Interfaces:
   1. Fire alarm system interfaces to be listed to UL 864 unless otherwise indicated.
   2. Descriptions below are intended to provide means for interface. Refer to project sequence of operations, narrative, and/or input/output matrix for execution requirements.
   3. Provide addressable monitor modules (Notifier Model FMM-1, Model FMM-101, or multi-point module) as indicated or as required for connection to addressable fire alarm control panel. Unless devices are explicitly permitted to be connected together as a zone, provide separate addressable monitoring point(s) for each device in order to be individually identifiable by addressable fire alarm control panel.
   4. Provide addressable relay module (Notifier Model FRM-1 or multi-point module) as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays (Notifier Model PR-1) suitable for load as required.
   5. Fire Sprinkler Systems:
      a. Waterflow Switches: Provide minimum of one monitoring point input per switch.
      b. Control Valve Supervisory (Tamper) Switches: Provide minimum of one monitoring point input per switch.
      c. Pressure Supervisory (High/Low Pressure) Switches: Provide minimum of two monitoring point inputs per switch (separate points for high/low pressure signals).
   6. Fire Suppression Systems:
      a. Releasing Service by Separate Panel (Not by Fire Alarm Control Panel):
         1) Provide minimum of four monitoring point inputs per system unless otherwise indicated.
         2) Kitchen Hood Suppression Systems: Provide minimum of one monitoring point input per system.
      b. Releasing Service by Fire Alarm Control Panel:
         1) Fire alarm control panel to be listed for releasing service.
         2) Provide addressable releasing control modules (Notifier Model FCM-1-REL) as indicated or as required for control of solenoids listed for releasing applications.
         3) Provide strobe(s) (Notifier Model SRL-P with Model LENS-R2 red lens) for visible notification as indicated. Interface to dedicated notification appliance circuit or control module, 24 VDC, supervised. Default operation to be flash on activation of first event, flash on release.
   7. Generator Systems:
      a. Provide minimum of two monitoring point inputs per system.
   8. Elevators:
      a. Elevator Emergency Recall Operation:

1) In each elevator machine room, provide interface for each elevator car or group of elevator cars as determined by authorities having jurisdiction via separate addressable relay modules for each of the output signals below where applicable.
   (a) Recall elevator to designated (primary) level.
   (b) Recall elevator to alternate level.
   (c) Smoke detection in elevator machine room (fire fighter's hat light).

9. Fire and Smoke Doors/Shutters/Curtains:
   a. Electromagnetic Door Holder Release:
      1) Provide output signal for release of electromagnetic door holders via addressable relay module and power isolation relay.
      2) Door holders to be powered via 120 VAC unless otherwise indicated.
   b. Automatic Fire and Smoke Door/Shutter/Curtain Release:
      1) Provide output signal for release of fire and smoke doors/shutters/curtains via addressable relay module and power isolation relay.
      2) Unless otherwise indicated, door/shutter/curtain release to be activated as determined by authorities having jurisdiction.
10. Lighting/Dimming Control Systems:
   a. System Override:
      1) Provide output signal to override lighting/dimming controls via addressable relay module and power isolation relay.
      2) Provide connection to UL 864 listed control system interface or interface with system control power where interruption of control power overrides system.
11. Sound and Audio/Visual Media Control Systems:
   a. System Override:
      1) Provide output signal to override sound and audio/visual media controls via addressable relay module and power isolation relay.
      2) Provide connection to UL 864 listed system interface or interface with system control power where interruption of control power overrides system.
12. HVAC Systems:
   a. Air Handling Units (AHUs) and Roof Top Units (RTUs):
      1) Provide duct smoke detector on supply side of air stream for units indicated on drawings.
      2) Provide duct smoke detector on return side of air stream for units with supply side duct smoke detectors.
      3) Provide remote test station for each duct smoke detector unless explicitly indicated as not required.
      4) Provide output signal to shut down units with at least one duct smoke detector via addressable relay module.
      5) Where fire/smoke dampers are located downstream of unit, provide monitoring point input to determine that unit is not operational and subsequently provide output signal to close such dampers via addressable relay module and power isolation relay.
13. Fire/Smoke Dampers:
   a. Provide output signal to close fire/smoke damper via addressable relay module and power isolation relay.
   b. Fire/smoke damper to be activated by the following method(s); where more than one method is listed see drawings for method to be used at each location.
      1) By addressable duct smoke detector as specified in this section.

14. Post-Fire Smoke Removal System - Non-Dedicated, with Control by Building Automation System:
    a. Exhaust Fans, Supply Fans, and Energy Recovery Units (ERUs): Interface with building automation system (BAS).
    b. Fire/Smoke Dampers Also Used for Post-Fire Smoke Removal: Interface with fire alarm system (FAS) as indicated under "Fire/Smoke Dampers" in this article above, but also provide monitoring point to confirm open status of damper.
    c. Provide the following output signals and monitoring point inputs at fire alarm control panel for interface with building automation system:
        1) One relay output per floor of building covered by post-fire smoke removal system.
        2) One relay output per exhaust fan, supply fan, and energy recovery unit (ERU) used for post-fire smoke removal, in order to send signal to BAS to place fan into post-fire smoke removal mode.
        3) One monitor input per exhaust fan, supply fan, and energy recovery unit (ERU) used for post-fire smoke removal, in order to receive signal from BAS that fan has been placed into post-fire smoke removal mode.
        4) One relay output for building general alarm condition.
        5) Five relay outputs for spare signals.
        6) Five monitor inputs for spare signals.

2.03 FIRE ALARM CONTROL PANELS AND ACCESSORY EQUIPMENT

A. Fire Alarm Control Panels and Accessory Equipment: Listed and labeled as complying with UL 864.

B. Provide cabinets and enclosures as indicated or as required to house system components.

C. Fire Alarm Control Panels:
    1. Basis of Design: Notifier ONYX Series Model NFS-320 configured with no voice and no networking capability.
    2. Basis of Design: Notifier ONYX Series Model NFS2-3030 configured with voice and networking capability.
        a. Supports up to 3180 devices (1590 detectors and 1590 modules) on up to 10 signaling line circuits (SLCs) configurable for Class B or Class A with Notifier Model LCM-320 loop control modules and Model LEM-320 loop expander modules.
        b. Main Panel/Fire Command Center: Provide Notifier Model NCA-2 640-character display/network control annunciator.
        c. Remote Nodes: Provide standard local display.
        d. Provide Notifier CAB-4 Series enclosure for mounting; include required dress plates and finish trims.

D. Emergency Voice/Alarm Communications System (EVACS):
    1. Provide digital multi-channel voice evacuation (EVACS) system integrated with fire alarm control panel capable of automatic and manual paging, messaging, evacuation, and alerting on a selective and all-call basis.
    2. Provide switch points of command as follows, unless otherwise approved by Engineer and authorities having jurisdiction:
        a. All-Call: Provides manual paging for all zones simultaneously.
        b. Total Evacuation: Provides complete building-wide activation of audio and visual evacuation signals; restore on switch deactivation, signal silence, or system reset command.
        c. Provide minimum of two switch points of manual controls per evacuation zone for manual paging and/or manual evacuation.

1) Manual Evacuation: Activate audio and visual evacuation signals on selected zone. Restore on switch deactivation, signal silence, or system reset command.
2) Manual Paging: Where active evacuation zone is selected, pause evacuation signal for manual page. Resume evacuation signal upon completion of paging function unless silence or reset command has been initiated.

d. In addition to required emergency messaging, provide switch points of command for minimum of three pre-recorded messages for non-emergency all-call notifications including "event has cleared", "testing of system", and "clear from testing of system".
e. Door Release: Provide switch points of command as required for unlocking of provisioned doors.
f. Provide minimum of six switch points of command for speaker bypass, visual bypass, elevator recall bypass, door control bypass, HVAC bypass, and auxiliary bypass.

3. Audio Transponders:
   a. Audio hardware, including multiple primary and backup amplifiers, speaker circuit interfaces, power supplies, supervision hardware, cabinets, and battery backup systems may be configured to support multiple notification zones and packaged as audio transponders.
   b. Transponders to be considered system control equipment and located, installed, and interfaced accordingly.
   c. Components mounted in transponders to be listed and approved for the installed configuration.
4. Basis of Design Products:
   a. Notifier DVC Series digital multi-channel voice evacuation (EVACS) system integrated with fire alarm control panel.
      1) Include auxiliary input for external 1 VRMS audio source (e.g. music, paging, etc), configurable to mute during emergency events and/or power loss.
      2) Digital Audio Protocol (DAP) communication channel allows connection to Notifier DAA2/DS Series amplifiers via manufacturer-approved cable media. DAP loop to be considered part of the fire alarm system network and meet specified requirements for wiring methods and pathway survivability.
      3) Capable of supporting up to 8 channels of simultaneous audio; each identified evacuation zone to allow broadcast of automatic audio or manual paging independent of other evacuation zones.
   b. Notifier BDA Series backup digital audio amplifiers.
      1) Provide dedicated backup amplifier for each primary amplifier. A backup amplifier may serve multiple primary amplifiers installed in a single enclosure.
      2) Provide automatic switching to backup amplification without use of additional hardware (e.g. relay modules, special tools) or programming.
   c. Remote command annunciator with remote microphone for selective zone paging consisting of:
      1) Notifier Model LCD-160 remote annunciator, 160-character LCD, indoor-rated.
      2) Notifier Model RM-1 remote microphone.
      3) Notifier ACM/AEM-24AT Series speaker control module; provide annunciation/control points as indicated or as required, each with alarm/circuit active LED, fault LED, touch-key switch, and provision for slip-in label.
      4) Notifier CAB-4 Series indoor-rated enclosure for housing components listed above.
   d. Notifier Model RM-1SA remote microphone for all-call paging.
      1) Provide Notifier Model CAB-RMR locking cabinet for mounting.

E. Networking:

1. Fire alarm control panel to be capable of communicating over network utilizing peer-to-peer, inherently regenerative communication and format.
2. Networks with Copper Media:
3. Basis of Design Products:
    a. Networks with Copper Media: Notifier Model NCM-W standard network communications module, twisted-pair copper wire interface; enables fire alarm control panel support of up to 103 network nodes over NOTI-FIRE-NET; Class B or Class A operation.

F. Releasing Service:
1. Fire alarm control panel to be capable of supporting 10 releasing zones for independent hazards, with each zone capable of three cross-zone and four abort options; provide adjustable delay and discharge timers.
2. Basis of Design Products:
    a. Potter Electric Signal Company Model 3001000 abort switch, with momentary red push button, stainless steel wallplate, and text "SUPPRESSION SYSTEM ABORT"; mounts to 2-gang box.
    b. Releasing Control Modules: See "Addressable Modules" in this article below.

G. Alarm Communication:
1. Digital Alarm Communicator Transmitters (DACT):
    a. Supports point and zone reporting via two telephone (POTS) lines.
2. Private Radio/Cellular Communicators: Furnished by others.
    a. Provide supervised monitoring of summary signals for alarm, trouble, supervisory, and carbon monoxide (where applicable) events via auxiliary contacts in fire alarm control panel.
    b. For redundancy, also interface with digital alarm communicator transmitter (DACT) to send point-specific events to central station.

H. Remote Annunciators:
1. Basis of Design Products:
    a. Notifier Model LCD-160 remote annunciator, 160-character LCD, indoor-rated.
        1) Provide Notifier Model ABS-2DR backbox (flush- or surface-mounting capability).
    b. For remote command annunciator with remote microphone for selective zone paging, see "Emergency Voice/Alarm Communications System (EVACS) Equipment" above.

I. Notification Appliance Circuit Expansion:
1. Where notification appliance circuit requirements exceed capacity of fire alarm control panel, provide accessories as required for expansion.
2. Basis of Design Products:
    a. Notifier FCPS-24S Series remote power supply/notification appliance circuit expansion panel.
        1) Provide four Class B notification appliance circuits (NACs), each rated for 2.5 A at 24 VDC and supervised for open, short, and overload conditions.
        2) Where Class A NACs are required, provide Notifier Model ZNAC-4 Class A module to enable each NAC to be configured as Class A or Class B.
        3) Provide supervised auxiliary power output rated for 0.5 A at 24 VDC.
        4) Provide minimum of one Notifier Model FCM-1 control module for each panel to allow for individual control and supervision of panel and reporting of fault conditions. Do not trigger or control multiple expansion panels via a single control module, NAC, or other "daisy chain" means that may result in loss of control due to failure or fault in one circuit.

5) Where panel split operation is required, provide additional Notifier Model FCM-1 control module (two total per panel); each module to trigger and control two of the four panel NACs.
6) Provide integral synchronization of both audio and visual circuits to match protocol assigned by fire alarm control panel.
7) Include provision for a "master sync circuit" to allow all system NACs (including fire alarm control panel and expansion panel circuits) in one building to have synchronized audio/visual circuits. Master sync circuit to be Class B and be independent of trigger and control circuits such that loss of master sync circuit does not cause loss of operation for audio and visual circuits.

J. Addressable Modules:
1. Provide addressable modules suitable for connection to fire alarm control panel signaling line circuits.
2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, non-hazardous locations.
3. Monitor Modules: Unless devices are explicitly permitted to be connected together as a zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control panel.
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.
8. Basis of Design Products:
a. Monitor Modules:
1) Notifier Model FMM-1 addressable monitor module; single monitoring point, supervises one Class A or Class B circuit of conventional dry-contact input devices; uses single module address on SLC; mounts to nominal 4 inch square or 2-gang box, includes white finish cover.
2) Notifier Model FDM-1 addressable monitor module; two monitoring points, supervises two Class B circuits of dry-contact input devices; uses two module addresses on SLC; mounts to nominal 4 inch square or 2-gang box, includes white finish cover.
3) Notifier Model FMM-101 addressable monitor module, miniature; single monitoring point, supervises one Class B circuit of conventional dry-contact input devices; suitable for installation within appropriately sized device box behind monitored unit; uses single module address on SLC.
4) Notifier Model FZM-1 addressable monitor module; single zone monitoring point, supervises one Class A or Class B zone of compatible two-wire conventional smoke detectors; requires separate 24 VDC power; uses single module address on SLC; mounts to nominal 4 inch square or 2-gang box, includes white finish cover.
b. Control Modules:
1) Notifier Model FCM-1 addressable control module; single supervised control output, Class A or Class B, suitable for controlling 24 VDC notification appliance

circuits (NAC) and speakers up to 70.7 VRMS; requires separate 24 VDC power; uses single module address on SLC; mounts to nominal 4 inch square or 2-gang box, includes white finish cover.

c. Releasing Control Module:
   1) Notifier Model FCM-1-REL addressable releasing control module; single supervised solenoid release output, Class A or Class B, suitable for connection to one 24 VDC solenoid or up to two 12 VDC solenoids (in series) listed for releasing service; utilizes redundant protocol; requires separate 24 VDC power; uses single module address on SLC; mounts to nominal 4 inch square or 2-gang box, includes white finish cover.

d. Relay Modules:
   1) Notifier Model FRM-1 addressable relay module; two Form C dry contacts that switch together; uses single module address on SLC; mounts to nominal 4 inch square or 2-gang box, includes white finish cover.

e. Multi-Input/Output Modules:
   1) Notifier Model FDRM-1 addressable multi-input/output module; two monitoring points, supervises two Class B circuits of dry-contact input devices; two Form C dry contacts that operate independently; uses up to four module addresses on SLC; mounts to nominal 4 inch square or 2-gang box, includes white finish cover.

f. Signaling Line Circuit (SLC) Isolating Modules:
   1) Notifier Model ISO-X addressable signaling loop circuit (SLC) isolating module; does not use any module addresses on SLC; mounts to nominal 4 inch square or 2-gang box, includes white finish cover.

g. Accessories:
   1) Notifier Model PR-1 power isolation relay for loads exceeding relay module contact ratings; operating voltage of 18-35 VDC, 18-35 VAC, or 120 VAC; LED visible indication of relay coil energization.

K. Electromagnetic Door Holders:
   1. Select according to door type and associated installation conditions.
   2. Basis of Design: Edwards Signaling 150* Series (* indicates placeholder for model number selected according to application).

2.04 FIRE ALARM SYSTEM INITIATING DEVICES

A. General Requirements:
   1. Addressable Devices: Individually identifiable by addressable fire alarm control panel; suitable for connection to fire alarm control panel signaling line circuits.
   2. Conventional (Non-Addressable) Devices: Provide addressable monitor modules (Notifier Model FMM-1, Model FMM-101, or multi-point module) as indicated or as required for connection to addressable fire alarm control panel. Unless devices are explicitly permitted to be connected together as a zone, provide separate addressable monitoring point for each device in order to be individually identifiable by addressable fire alarm control panel.
   3. Provide devices and associated accessories suitable for intended application and location to be installed. Unless otherwise indicated, use addressable devices and addressable monitor modules only in clean, dry, indoor, non-hazardous locations.
   4. Surface-Mounted Devices: Provide manufacturer's accessory surface mount backboxes or suitable outlet/device box.
   5. Devices for Outdoor and Damp/Wet Locations: Weatherproof, suitable for outdoor use; provide manufacturer's accessory backboxes and/or enclosures in accordance with product listing.

6. Devices for Hazardous (Classified) Locations: Listed and labeled as suitable for the classification of the installed location.

B. Manual Fire Alarm Boxes (Pull Stations):
   1. Description: Non-coded manual signaling boxes listed and labeled as complying with UL 38.
   2. Alarm Initiation: Configured for general alarm initiation unless otherwise indicated; pre-signal stations (where indicated) require use of key to initiate general alarm.
   3. Operation: Dual-action unless otherwise indicated; first requires pushing in then pulling down of lever.
   4. Color: Red, in accordance with NFPA 72.
   5. Station Reset: Requires use of key or tool.
   6. Protective Covers for Manual Pull Stations:
      a. Provide protective covers with hinged access for manual pull stations.
      b. Listed and labeled as complying with UL 38.
   7. Basis of Design Products:
      a. Manual Pull Stations:
         1) Notifier Model NBG-12LX addressable manual pull station, indoor-rated, dual-action, key lock.
      b. Protective Covers for Manual Pull Stations:
         1) STI (Safety Technology International) Model STI-1100 protective cover with horn for indoor flush-mounted manual pull station.
         2) STI (Safety Technology International) Model STI-1200 protective cover without horn for indoor flush-mounted manual pull station.
      c. Surface Mount Backboxes:
         1) Notifier Model SB-I/O surface mount backbox for indoor or outdoor wall-mounted manual pull station, plastic.

C. Spot-Type Detectors:
   1. Addressable Detectors:
      a. Provide LED indication of normal operation/regular communication with fire alarm control panel and alarm condition.
      b. Furnished with output for remote LED alarm indicator.
      c. Utilizes plug-in mounting to separate base with tamper-resistant feature; compatible with available sounder, relay, and isolator bases; provide base as indicated or as required.
   2. Smoke Detectors:
      a. Listed and labeled as complying with UL 268.
   3. Thermal (Heat) Detectors:
      a. Listed and labeled as complying with UL 521.
   4. Carbon Monoxide Detectors:
      a. Listed and labeled as complying with UL 2075.
      b. Furnished with end-of-life notification.
   5. Detector/Base Color: White, unless otherwise indicated.
   6. Basis of Design Products:
      a. Smoke Detectors:
         1) Notifier Model FSP-951 addressable smoke detector, indoor-rated, photoelectric, integral drift compensation, self-diagnostics, transient rejection, local test via application of external magnet.
      b. Thermal (Heat) Detectors:

1) Notifier Model FST-951 addressable thermal detector, indoor-rated, fixed temperature, 135 degrees F, local test via application of external magnet.
2) Notifier Model FST-951H addressable thermal detector, indoor-rated, fixed temperature, 190 degrees F, local test via application of external magnet.

c. Carbon Monoxide Detectors:
1) Notifier Model CO1224TR conventional carbon monoxide detector, indoor-rated, wall- or ceiling-mounting capable.

d. Natural Gas (Methane) (CH_4) detector:
1) Honeywell Sensepoint XCD with a 4-20 mA analog output and connect it through a NOTIFIER FMM-4-20 module. Wall or ceiling mounted.

e. Combination/Multi-Criteria Detectors:
1) Notifier Model FPTI-951 addressable smoke/thermal detector, indoor-rated; photoelectric smoke sensor; fixed temperature thermal sensor, 135 degrees F, automatic sensitivity adjustment.

f. Bases for Addressable Detectors:
1) Notifier Model B300-6 Series standard base, flanged low-profile.
2) Notifier Model B200S-LF Series low-frequency sounder base.

g. Detector Accessories:
1) Notifier Model RA100Z remote indicator; provides LED indication of alarm condition.
(a) Up to two remote indicators may be connected to single detector.
(b) Provide addressable relay modules (Notifier Model FRM-1 or multi-point module) where more than two remote indicators are required for single detector or where multiple detectors are to control the same remote indicator(s).

D. Duct Smoke Detectors:
1. Listed and labeled as complying with UL 268A.
2. Sampling Tubes: Select as required for installation in duct to be monitored.
3. Remote Test Stations: Provide remote test station for each duct smoke detector unless explicitly indicated as not required. Unless otherwise indicated, use remote test stations only in clean, dry, indoor, non-hazardous locations.
4. Basis of Design Products:
a. Addressable duct smoke detector assembly for indoor applications consisting of:
1) Notifier Model FSP-951R addressable smoke detector, indoor-rated, photoelectric, remote test capable.
2) Notifier DST Series sampling tube of appropriate length.
b. Addressable duct smoke detector assembly for outdoor applications consisting of:
1) Notifier Model FSP-951R addressable smoke detector, indoor-rated, photoelectric, remote test capable.
2) Notifier DST Series sampling tube of appropriate length.
3) Notifier Model DH400OE-1 weatherproof enclosure for housing components listed above. Fill interior of enclosure with appropriate insulation media to minimize condensation.
c. Notifier Model RTS151 remote test station for addressable detectors; allows for detector test (via external magnet application) and reset; provides LED indication of alarm condition.

2.05 FIRE ALARM SYSTEM NOTIFICATION APPLIANCES

A. Notification Appliances - General Requirements:

1. Provide signaling devices listed for fire-protective service and intended operating mode (public or private); suitable for connection to fire alarm control panel notification appliance circuits (NAC).
2. Provide control modules (Notifier Model FCM-1) as indicated or as required for selective control of notification appliances.
3. Provide devices and associated accessories suitable for intended application and location to be installed. Use devices only according to listed mounting (e.g. ceiling, wall).
4. Surface-Mounted Devices: Provide manufacturer's accessory surface mount backboxes or suitable outlet/device box.
5. Devices for Outdoor and Damp/Wet Locations: Weatherproof, suitable for outdoor use; provide manufacturer's accessory backboxes and/or enclosures in accordance with product listing.
6. Device Derating: Account for device derating adjustments in accordance with listing where applicable, including but not limited to the following.
   a. Where accessory protective guards, enclosures, etc. are utilized.
   b. Where required by field conditions (e.g. ambient temperature).

B. Visible Notification Appliances:
1. Public Mode Operation: Listed and labeled as complying with UL 1971.
2. Private Mode Operation: Listed and labeled as complying with UL 1638.
3. Strobes: Clear or nominal white lens with flash rate of 1 Hz unless otherwise indicated or required; xenon light source with maximum pulse duration of 0.2 seconds; candela rating as indicated.
   a. Where field-selectable candela strobes are specified, substitution of fixed candela strobes is not permitted.

C. Speakers for Emergency Voice/Alarm Communications Systems (EVACS):
1. Listed and labeled as complying with UL 1480.
2. Rated Sound Pressure Level: As required to achieve design sound pressure levels, but not less than 75 dB(A) at 10 feet in accordance with UL 1480.
3. Frequency Range: 400 to 4,000 Hz minimum in accordance with UL 1480; listed for producing 520 Hz low frequency alarm signal for sleeping areas in accordance with NFPA 72.
4. Speaker Voltage: Field-selectable (25 V, 70.7 V); matched to audio distribution circuit.
5. Furnished with minimum of four field-selectable power taps.

D. Combination Notification Appliances: Comply with respective requirements for each signaling method.

E. Basis of Design Products:
1. Strobes:
   a. Notifier Model SRL strobe, indoor-rated, wall-mounted, red, selectable candela output (15, 30, 75, 95, 110, 135, 185 at 24 VDC nominal).
   b. Notifier Model SCRL strobe, indoor-rated, ceiling-mounted, red, selectable candela output (15, 30, 75, 95, 115, 150, 177 at 24 VDC nominal).
2. Speakers:
   a. Notifier Model SPRL speaker, indoor-rated, wall-mounted, red.
3. Speaker/Strobes:
   a. Notifier Model SPSRL speaker/strobe, indoor-rated, wall-mounted, red, selectable candela output (15, 30, 75, 95, 110, 135, 185 at 24 VDC nominal).
   b. Notifier Model SPSCRL speaker/strobe, indoor-rated, ceiling-mounted, red, selectable candela output (15, 30, 75, 95, 115, 150, 177 at 24 VDC nominal).

c. Notifier Model SPSCWK speaker/strobe, weatherproof (includes backbox), ceiling-mounted, white, selectable candela output (15, 15/75, 30, 50, 75, 95, 110, 115 at 24 VDC nominal).

4. Surface Mount Backboxes:
   a. Notifier Model SPBBRL surface mount backbox for indoor wall-mounted speaker or speaker/strobe, red.
   b. Notifier Model SBBCRL surface mount backbox for indoor ceiling-mounted horn, speaker, strobe, horn/strobe, or speaker/strobe, red.

2.06 FIRE ALARM SYSTEM ACCESSORIES

A. Cables for Network Connections: Comply with Section 271000 and manufacturer's minimum requirements.

B. Fire Alarm System Documents and Software (FAD) Cabinet:
   1. Provide fire alarm document (FAD) cabinet with size as indicated or as required.
   2. Cabinet: Steel with red finish; permanently identified with text "FIRE ALARM SYSTEM DOCUMENTS"; keyed to match fire alarm system equipment; include fixed integral minimum 2GB flash drive for electronic storage of system documents and system database program
   3. Basis of Design Products:
      a. Space Age Electronics FAD Series, Model SSU00690 cabinet, 12 inches wide by 13 inches high by 2-1/4 inches deep, keyed; provide special keying complying with requirements of authorities having jurisdiction where necessary.

C. Terminal Cabinets:
   1. Provide terminal cabinets with quantity of termination points as indicated or as required for application.
   2. Cabinet: Steel, with red finish; permanently identified with text "FIRE ALARM TERMINAL CABINET"; keyed to match fire alarm system equipment.
   3. Terminal Strips: Rated for 20 A at 250 V; terminal points rated for 12 AWG conductors.
   4. Basis of Design Products:
      a. Space Age Electronics TC Series, Model SSU00645 terminal cabinet with 32 termination points, keyed.

D. As-Built Document Cabinets:
   1. Provide as-built document cabinet with size as indicated or as required.
   2. Cabinet: Steel with red finish; permanently identified with text "AS-BUILT DRAWINGS"; keyed to match fire alarm system equipment.
   3. Basis of Design Products:
      a. Space Age Electronics DBX Series, Model SSU00677 drawing cabinet, 26-1/4 inches wide by 14-1/4 inches high by 4 inches deep, keyed; provide special keying complying with requirements of authorities having jurisdiction where necessary.

E. Framed Passive Graphic Maps:
   1. Provide appropriately-sized passive graphic map of protected premises that identifies:
      a. Location and address of all system addressable input devices.
      b. Room numbers or descriptions for rooms with devices that match device labels.
      c. Current location (labeled "YOU ARE HERE").
      d. North reference.
   2. Provide concealed mounting hardware.
   3. Basis of Design Products:
      a. Space Age Electronics GD8 Series graphic display frame; aluminum with matte finish and red trim.

F. Surge Protection:
   1. Line Voltage Surge Protection: UL 1449 listed; provide for each line voltage circuit that supplies operating power for fire alarm system control equipment (e.g. fire alarm control panel, field booster panels, nodes, transponders, etc).
   2. Low Voltage Surge Protection: Listed, voltage/current ratings suitable for circuit to be protected; provide for each power limited low voltage circuit that exits the protected premises.
   3. Basis of Design Products:
      a. Space Age Electronics Model E120V-GT line voltage surge protection, 120 VAC.
      b. Space Age Electronics TDG Series low voltage surge protection.

2.07 SINGLE- AND MULTIPLE-STATION ALARMS

A. Single- and Multiple-Station Alarms:
   1. Utilize plug-in mounting with tamper-resistant feature.
   2. Furnished with alarm test and silence features.
   3. Self-restoring; automatic alarm reset upon clearing of alarm condition.
   4. Provide alarm latch for interconnected units for visible indication of which unit initiated alarm.

B. Smoke Alarms:
   1. Listed and labeled as complying with UL 217.

C. Heat Alarms:
   1. Listed and labeled as complying with UL 539.

D. Carbon Monoxide Alarms:
   1. Listed and labeled as complying with UL 2034.
   2. Furnished with end-of-life notification.

PART 3 EXECUTION

3.01 EXAMINATION (BY INSTALLER)

A. Verify that field measurements are as indicated.

B. Verify that characteristics of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that circuit wiring installation is completed, tested, and ready for connection to system where applicable per conductor requirements of NFPA 72 Table 14.4.3.2 (15) and (16).

E. 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 products in accordance with applicable requirements of NECA 1 (general workmanship).

C. Adjust selectable candela strobes to rating indicated on design documents.

D. Provide grounding and bonding in accordance with manufacturer's recommendations and 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, components, and overcurrent protective devices for branch circuits serving fire alarm system 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 prepare and start systems and support inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

E. Provide equipment, tools, supplies, two-way radios, and personnel required to accomplish inspection and testing.

F. Prepare and start system in accordance with manufacturer's instructions.

G. Program system parameters according to project requirements.

H. Perform initial and acceptance inspection and testing in accordance with NFPA 72 and requirements of authorities having jurisdiction; document each inspection and test.

I. Test for proper interface with other systems.

J. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

K. Installer to submit NFPA 72 reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. See Section 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL, for additional requirements.

B. 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.
   1. Be prepared to conduct any of the required tests.
   2. Have at least one copy of operation and maintenance data, copy of project record drawings, input/output matrix, and operator instructions available during demonstration.
   3. Have manufacturer's authorized representative present during demonstration.
   4. Demonstration may be combined with inspection and testing required by authorities having jurisdiction.

D. Training: Owner Personnel Instruction:
   1. Provide the following instruction to designated Owner personnel:
      a. Hands-On Instruction: On-site, using operational system.
      b. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
   2. Basic Operation: One 1-hour session pre-closeout for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on.
   3. Detailed Operation: One 2-hour session post-occupancy for engineering staff holding appropriate State license to operate, service, or maintain fire alarm systems; assume NICET Level I qualifications or equivalent; combination of classroom and hands-on.
   4. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

5. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

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 fire alarm system for entire manufacturer's warranty period to include the work described below; include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72 and 527 CMR 1.00, including:
   1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
   2. Repairs required outside of warranty as approved by Owner.
   3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include fee schedule for call-back service during and outside normal working hours; include definition of normal working hours.

E. Maintain an on-site log 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.

END OF SECTION 284600

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SECTION 310519
GEOSYNTHETICS FOR EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Geotextile for separation.

B. Geotextile for filtration.

C. Geotextile for protection.

D. Geogrid for stabilization.

E. Geogrid for reinforcement.

F. Geomembrane for barrier.

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. AASHTO M 288 - Standard Specification for Geosynthetics for Highway Applications; 2024.

B. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).

C. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus; 2021.

D. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 2022.

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 (Reapproved 2023).

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; 2021a.

J. ASTM D4833/D4833M - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products; 2007 (Reapproved 2020).

K. ASTM D4873/D4873M - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples; 2017 (Reapproved 2021).

L. ASTM D4886 - Standard Test Method for Abrasion Resistance of Geotextiles (Sandpaper/Sliding Block Method); 2023.

M. ASTM D5199 - Standard Test Methods for Measuring the Nominal Thickness of Geosynthetics; 2025.

N. ASTM D5321/D5321M - Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear; 2026.

O. ASTM D6241 - Standard Test Method for Measuring Static Puncture Strength of Geotextiles and Geosynthetic-Related Products Using a 50?mm Probe; 2022a.

P. ASTM D6637/D6637M - Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method; 2015 (Reapproved 2023).

Q. ASTM D6706 - Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil; 2001 (Reapproved 2021).

R. ASTM D7737/D7737M - Standard Test Method for Individual Geogrid Junction Strength; 2015 (Reapproved 2023).

S. GRI GM13 - Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes; 2021.

T. GRI GM32 - Geomembrane Seaming Using Data Acquisition Hot Wedge Welding Devices; 2019.

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: Manufacturer's data on each product to be used, including physical properties, seaming materials, and installation instructions.

C. Shop Drawings:
   1. Indicate overall layout, dimensions, geotextile sheet and seam layout.
      a. For Fill Slope Stabiliation as indicated on the contract drawings.

1.06 QUALITY ASSURANCE

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

1.07 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.

1.08 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 MANUFACTURERS

A. SKAPS Industries; _____: www.skaps.com/#sle.

B. Solmax: www.solmax.com/#sle.

C. US Fabrics Inc: www.usfabricsinc.com/#sle.

2.02 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.

2.03 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 Separation: Capable of restricting adjacent material mixing.
   1. Type: Woven.
   2. Seams: Loose laid.
      a. Overlap: According to manufacturer.
         1) 12 inches (300 mm), minimum, in all directions.
   3. Grab Strength: 300 lb (1.3 kN), minimum, when tested in accordance with ASTM D4632/D4632M.
   4. Puncture Strength: 90 lb (400 kN), minimum, when tested in accordance with ASTM D4833/D4833M.

C. Geotextile for Filtration: Capable of allowing liquid passage while restricting solids.
   1. Type: Nonwoven.
   2. Seams: Mechanically sewn.
      a. Overlap: 3 inches (7.6 cm).
      b. Stitch: Flat; continuous; tied off at ends.
   3. Grab Strength: 200 lb (_____ kN), minimum, when tested in accordance with ASTM D4632/D4632M.
   4. Permittivity: 0.5 per second, minimum, ASTM D4491/D4491M.
   5. Apparent Opening Size: No.40 (0.425 mm), maximum, when tested in accordance with ASTM D4751.
   6. Sewn Seam Strength: 275 lb (1.25kN), minimum, when tested in accordance with ASTM D4632/D4632M.

D. 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.

E. Geotextile Accessories:
   1. Seaming Thread: High-strength; as recommended by manufacturer; contrasting color.

2.04 GEOGRID

A. General:
   1. Material: Polyethylene consisting of 5 percent maximum regrind and free of contaminants.
   2. Tensile Strength at 2 percent Strain: 400 lb/ft (5.8 kN/m), minimum, when tested in accordance with ASTM D6637/D6637M.
   3. Tensile Strength at 5 percent Strain: 800 lb/ft (11.7 kN/m), minimum, when tested in accordance with ASTM D6637/D6637M.

B. Geogrid for Stabilization: Capable of reducing deformation of unbound granular materials.
   1. Seams: Loose laid.
      a. Overlap: According to manufacturer.
   2. Ultimate Tensile Strength: 1,300 lb/ft (19.0 kN/m), minimum, when tested in accordance with ASTM D6637/D6637M.
   3. Junction Strength: 25 lb (0.11 kN), minimum, when tested in accordance with ASTM D7737/D7737M.

C. Geogrid for Reinforcement: Capable of increasing tensile strength of soils.
   1. Seams: Spliced.
      a. Overlap: According to manufacturer.
      b. Splice: Fusion wedge welding.
   2. Ultimate Tensile Strength: 4,000 lb/ft (58.4 kN/m), minimum, when tested in accordance with ASTM D6637/D6637M.
   3. Junction Strength: 50 lb (0.22 kN), minimum, when tested in accordance with ASTM D7737/D7737M.

2.05 GEOMEMBRANE

A. Geomembrane for Barrier: Capable of preventing fluid passage.
   1. HDPE Liner: Plastic sheet, comply with GRI GM13.
      a. Thickness: 60 mils, 0.06 inch.
      b. Sided: Single.
   2. Seams: Thermal fusion.
      a. Overlap: 6 inches, minimum.
      b. Thermally Fused Seams:
         1) Single hot wedge, according to GRI GM32.

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. Separation:
1. Install geotextile according to manufacturer's recommendations.
2. Lay sheets in the direction of construction.
3. Repairs: Remove damaged portion of geotextile and seam an additional layer to cover the affected area in all directions.

C. Filtration:
1. Install geotextile according to manufacturer's recommendations.
2. Lay sheets in the direction of construction.
3. Repairs: Remove damaged portion of geotextile and seam an additional layer to cover the affected area in all directions. Replace geotextile where surface runoff contamination has occurred.

D. 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.

E. Stabilization:
1. Install geogrid according to manufacturer's recommendations.
2. Lay sheets in the direction of construction.
3. Allow geogrid to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
4. Repairs: Remove damaged portion of geogrid and seam an additional layer to cover the affected area in all directions.

F. Reinforcement:
1. Install geogrid according to manufacturer's recommendations.
2. Lay sheets in the direction of reinforcement.
3. Allow geogrid to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
4. Repairs: Remove damaged portion of geogrid and seam an additional layer to cover the affected area in all directions.

G. Barrier:
1. Install geomembrane according to manufacturer's recommendations.
2. Lay sheets in the direction of incline.
3. Allow geomembrane to lie in a relaxed state for a minimum of 1/2 hour prior to attachments.
4. Repairs: Remove damaged portion of geomembrane 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 310519

SECTION 311000
SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clearing and grubbing.

B. Selective removal and trimming.

C. Earth stripping and stockpiling.

D. Repair and restoration.

E. Debris removal.

1.02 REFERENCE STANDARDS

A. 29 CFR 1910.266 - Logging Operations; Current Edition.

B. ANSI Z133 - American National Standard for Arboricultural Operations - Safety Requirements; 2017.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene prework meeting at least one week prior to start of work of this section; require attendance by affected personnel.

1.04 SUBMITTALS

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

B. Site Plan:
   1. Indicate vegetation removal limits.
   2. Indicate areas for temporary construction and field offices.

C. Clearing Firm Qualification Statement: Documentation of specialized experience.

1.05 QUALITY ASSURANCE

A. Clearing Firm Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.

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.

B. Identify potential runoff areas.

C. Construction Fencing: See Section 015000 - Temporary Facilities and Controls.

D. Boundary Demarcations: See Section 017123 - Field Engineering.

E. Identify potential dust sources.

F. Identify preexisting debris, junk, and trash on-site.

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.

F. Develop dust remediation controls and methods. Do not use water if that results in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

G. Remove preexisting debris, junk, and trash on-site.

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.

E. Grubbing: Remove stumps, roots, buried timber, and other vegetation minimum depth 12 inches (30 cm) from ground. Remove rocks minimum depth 6 inches (15 cm) from ground.

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 EARTH STRIPPING AND STOCKPILING

A. Stripping:
   1. Remove topsoil within identified area as indicated on drawings.

B. Stockpiling:
   1. Place topsoil in identified areas as indicated on drawings or areas indicated by Owner and Construction Manager:
      a. Pile depth not to exceed 8 feet.
      b. Protect piles from erosion.

3.06 REMOVED VEGETATION PROCESSING

A. Do not burn, bury, landfill, or leave on-site, except as indicated on drawings.

B. Trees: Sell if marketable.

C. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; give preference to on-site uses.

3.07 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 Represenative.

3.08 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 311000

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SECTION 312200
GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of topsoil.

B. Rough grading the site for site structures.

C. Finish grading.

1.02 RELATED REQUIREMENTS

A. Section 311000 - Site Clearing.

B. Section 312316.13 - Trenching: Trenching and backfilling for utilities.

C. Section 312323 - Fill.

D. Section 329219 - Seeding: Finish ground cover.

E. Section 329223 - Sodding: Finish ground cover.

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. Topsoil: See Section 312323.

B. Other Fill Materials: See Section 312323.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work 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 from damage above- and below-grade utilities to remain.

D. Provide temporary means and methods to remove all 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, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

F. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.

G. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.03 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

D. Do not remove wet subsoil , unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

G. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.04 SOIL REMOVAL

A. Stockpile topsoil to be re-used on site; remove remainder from site.

B. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.

C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

D. Place topsoil in areas indicated.

E. Place topsoil to thickness as indicated.

F. Place topsoil during dry weather.

G. Remove roots, weeds, rocks, and foreign material while spreading.

H. Near plants spread topsoil manually to prevent damage.

I. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

J. Lightly compact placed topsoil.

K. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.06 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.07 FIELD QUALITY CONTROL

A. See Section 312323 for compaction density testing.

3.08 CLEANING

A. Remove unused stockpiled topsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 312200

SECTION 312316
EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for building volume below grade, footings, pile caps, slabs-on-grade, paving, site structures, and utilities within the building.

B. Trenching for utilities outside the building to utility main connections.

C. Temporary excavation support and protection systems.

1.02 RELATED REQUIREMENTS

A. Section 210553 - Identification for Fire Suppression Piping and Equipment: Underground warning tapes at underground fire suppression lines.

B. Section 220553 - Identification for Plumbing Piping and Equipment: Underground warning tapes at underground plumbing lines.

C. Section 230553 - Identification for HVAC Piping and Equipment-CPL: Underground warning tapes at underground HVAC lines.

D. Section 260553 - Identification for Electrical Systems: Underground warning tapes at underground electrical lines.

E. Section 312200 - Grading: Grading.

F. Section 312316.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

G. Section 312316.26 - Rock Removal: Removal of rock during excavating.

H. Section 312323 - Fill: Fill materials, backfilling, and compacting.

I. Section 329119 - Landscape Grading.

1.03 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

1.04 QUALITY ASSURANCE

A. Temporary Support and Excavation Protection Plan:
   1. Indicate sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
   2. Include drawings and calculations for bracing and shoring.
   3. Bracing and shoring design to meet requirements of OSHA's Excavation Standard, 29 CFR 1926, Subpart P.

B. Designer Qualifications: For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

PART 2 PRODUCTS

2.01 MATERIALS

A. Underground Warning Tapes:
   1. See Section 220553 for underground warning tapes at underground plumbing lines.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

B. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.
   1. Resurvey benchmarks during installation of excavation support and protection systems and notify Owner if any changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by Architect. If the proposed excavation extends more than 1 foot into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by Geotechnical Engineer.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect utilities that remain and protect from damage.

C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

D. Protect plants, lawns, rock outcroppings, and other features to remain.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect.

3.03 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
   1. Excavations in stable rock or in less than 5 feet in depth in ground judged as having no cave-in potential do not require excavation support and protection systems.
   2. Depending upon excavation depth, time that excavation is open, soil classification, configuration and slope of excavation sidewalls, design and provide an excavation support and protection system that meets the requirements of 29 CFR 1926, Subpart P:
      a. Sloping and benching systems.
      b. Support systems, shield systems, and other protective systems.

B. Excavation support and protection systems not required to remain in place may be removed subject to approval of Owner or Owner's Representative.
   1. Remove temporary shoring and bracing in a manner to avoid harmful disturbance to underlying soils and damage to buildings, structures, pavements, facilities and utilities.

3.04 EXCAVATING

A. Excavate to accommodate new structures and construction operations.
   1. Excavate to the specified elevations.
   2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.
   3. Cut utility trenches wide enough to allow inspection of installed utilities.
   4. See Section 312316.26 for required excavation clearances for pipes in utility trenches.

B. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Preparation for Piling Work: Excavate to working elevations. Coordinate special requirements for piling.

D. Do not interfere with 45 degree bearing splay of foundations.

E. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume. See Section 312316.26 for removal of larger material.

F. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.05 SUBGRADE PREPARATION

A. See Section 312316.13 for subgrade preparation at utility trenches.

3.06 FILLING AND BACKFILLING

A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.

B. Install underground warning tape at buried utilities according to Sections 210553, 220553, 230553, and 260553.

C. See Section 312323 for fill, backfill, and compaction requirements at general excavations.

D. See Section 312316.13 for fill, backfill, and compaction requirements at utility trenches.

E. See Section 312200 for rough and fine grading.

F. See Section 329119 for topsoil placement and finish grading.

3.07 REPAIR

A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323.

3.08 FIELD QUALITY CONTROL

A. See Section 014000 - BSD Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces by Architect before placement of foundations.

3.09 CLEANING

A. Stockpile excavated material to be re-used in area designated on site in accordance with Section 312200.

B. Remove excavated material that is unsuitable for re-use from site.

C. Remove excess excavated material from site.

3.10 PROTECTION

A. Divert surface flow from rains or water discharges from the excavation.

B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.

D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION 312316

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SECTION 312316.13
TRENCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backfilling and compacting for utilities outside the building to utility main connections.

1.02 SUBMITTALS

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

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

D. Compaction Density Test Reports.

1.03 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.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Use all fill materials as listed below unless otherwise noted within the contract drawings. No recycled materials will be accepted.

B. General Fill - Fill Type 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. within Section 312323 - Fill..

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 NYS DOT (Item 203.07 and Section 733-11) standard, meetting the below gradation requirements:
   1. Graded in accordance with ASTM C136/C136M, within the following limits:
      a. 3 inch sieve: 100 percent finer by weight.
      b. 1/4 inch sieve: 25 to 65 percent finer by weight.
      c. No. 40: 5 to 40 percent finer by weight.
      d. No. 200: 0 to 10 percent finer by weight.

E. Concrete for Fill: Lean concrete.

F. 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.
      d. No. 200: 5 to 10 percent passing.

G. 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".

H. Sand: ASTM C 33; fine aggregate Complying with State of New York Highway Department standard.

I. Topsoil: See Section 312200.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect utilities that remain and protect from damage.

C. Notify utility company to remove and relocate utilities.

D. Protect bench marks, survey control points, 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. 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.

3.03 TRENCHING

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 large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

G. Remove excavated material that is unsuitable for re-use from site.

H. Stockpile excavated material to be re-used in area designated on site.

I. Remove excess excavated material from site.

J. 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.

K. 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.

3.04 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.

3.05 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a 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. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 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: Use general fill, 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.

3.06 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Utility Piping
   1. Bedding: Use Fill Type Granular Bedding Stone.
   2. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

B. At Pipe Culverts:
   1. Bedding: Use Fill Type Granular Bedding Stone.
   2. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

C. At French Drains:
   1. Use Fill Type Drainage Course .
   2. Compact to 95 percent of maximum dry density.

3.07 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. If tests indicate work does not meet specified requirements, 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.

3.08 CLEANING

A. Leave unused materials in a neat, compact stockpile.

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 312316.13

SECTION 312316.26
ROCK REMOVAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Removing identified and discovered rock during excavation.
   2. Expansive tools to assist rock removal.
   3. Blasting is not permitted during rock removal activities.

B. Related Sections:
   1. Division 31 - Earthwork.

1.03 REFERENCE STANDARDS

A. Code of Federal Regulations Title 29 - Labor, Part 1926 Safety and Health Regulations for Construction (OSHA).

1.04 DEFINITIONS

A. Rock: Limestone, sandstone, shale, granite and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.0 cu yd. Concrete building foundations and concrete slabs, not indicated, with a volume greater than 1.0 cu yd shall be classified as rock.
   1. Limestone, sandstone, shale, granite, and similar material in a broken or weathered condition which can be removed with an excavator or backhoe equipped with a bucket with ripping teeth or any other style bucket shall be classified as earth excavation.
   2. Masonry building foundations, whether indicated or not, shall be classified as earth excavation.

B. Unauthorized Rock Removal:
   1. The removal of any rock prior to performing the measurements/work required to determine quantities.
   2. The removal of material below required elevation indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner or Architect.

C. General Rock Removal: Quantities of rock removal will be paid for as Mass Rock Removal when:
   1. The width of rock removed, as per measurement limits, is greater than or equal to the total excavation depth required.
   2. Boulders removed have a volume greater than 1.0 cu yd.

D. Trench Rock Removal: Quantities of rock removal will be paid for as Trench and Pier Rock Removal when the width of rock removed, as per measurement limits, is less than the total excavation depth required.

1.05 SUBMITTALS

A. Manufacturer’s installation instructions shall be provided along with product data.

B. Rock Removal Procedure: Submit a detailed outline of intended rock removal procedure for the Owner’s Representative’s information. This submittal will not relieve the Contractor of responsibility for the successful performance of the Work.

C. Measurement data for quantities of rock removal.

D. Survey Report: Submit survey report on conditions of buildings near locations of rock removal.

1.06 QUALITY ASSURANCE

A. Pre-Rock Removal Conference: Before the rock removal work is scheduled to commence, a conference will be called by the Owner's Representative at the Site for the purpose of reviewing the Contract Documents and discussing requirements for the Work. The conference shall be attended by the Contractor's Representative and the person supervising the rock removal operations.

1.07 PROJECT CONDITIONS

A. Explosive methods and the use of explosive materials will not be permitted.

B. Conduct survey and document conditions of buildings near locations of rock removal, prior to blasting, and photograph existing conditions identifying existing irregularities.

C. Advise Owner’s Representative of adjacent buildings or structures in writing, prior to executing seismographic survey. Explain planned blasting and seismic operations.

D. Obtain seismic survey prior to rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties or other work.

1.08 SCHEDULING

A. Schedule Work to avoid working hours of occupied buildings nearby.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and verify site conditions and note any subsurface irregularities, site defects, or site deterioration affecting Work of this section. Make this information available to the Owner’s Representative upon request.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Prior to removing material classified as rock, excavate test pits down to rock for the purpose of verifying the presence of sound rock and determining top of rock elevations.
   1. Verification of Sound Rock: Demonstrate to the Owner’s Representative that materials to be classified as rock cannot be removed utilizing a backhoe or excavator equipped with any form of bucket, including a bucket equipped with ripping teeth.
   2. Required Measurements: Take elevations and measurements as required for the purpose of determining the quantities of rock removal. Record all measurement data and submit a copy of the data to the Owner's Representative. Backfill test pits prior to rock removal as directed. Unless otherwise indicated or directed, excavate test pits as follows:
      a. For Structures: One pit for each structure or one pit for each 1000 sq ft, whichever is greater.
      b. For Paved Areas: 3 pits for each 2500 sq ft.
      c. For Utility Lines: One pit for each 100 linear ft.
   3. If rock removal quantities are greater than 1,000 cubic yards, the measurement of the top of rock elevations both prior to and following removal of rock shall be performed by a New York licensed surveyor.

C. Schedule a site meeting with the Owner’s Representative and facility personnel to review the rock removal procedures in detail.

D. If required, have seismographs in place and operational as well as all safety equipment and/or fencing.

3.03 ROCK REMOVAL BY MECHANICAL METHOD

A. Excavate and remove rock by mechanical method.
   1. Drill holes and use expansive tools to fracture rock.

B. Cut away rock at bottom of excavation to form level bearing.

C. Remove loose fragments to provide an unfractured, suitable base per engineering design for footings.

D. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

E. Remove from Property and dispose of excess and unsuitable rock materials.

F. Transport excess and unsuitable rock materials to spoil areas on property designated by the Owner's Representative and dispose of such materials as directed.

G. Correct unauthorized rock removal as follows:in accordance with backfilling and compacting requirements of Section 310000

3.04 VOLUME DETERMINATION

A. Top of Rock Elevations established prior to the performance of any rock removal (Article 3.2) will be used to determine the depth of rock removed. Measurements for the base and width of the rock excavation shall be taken of the actual rock cut, as required for the Work, or to the specified measurement limits, whichever is smaller. Unless otherwise directed in writing, measurement limits for this work shall be as follows:
   1. Pipe:
      a. Vertical Limit: Bottom of rock cut for pipe in trench shall be 6 inches below the required pipe invert elevation, with depth measured from the mean surface of the rock.
      b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

ACTUAL DEPTH OF ROCK CUT	**TRENCH WIDTH**
UNDER 10 FEET	**24 INCHES PLUS PIPE OD**
10 TO 15 FEET	**36 INCHES PLUS PIPE OD**
OVER 15 FEET	**48 INCHES PLUS PIPE OD**

   2. Conduit:
      a. Vertical Limit: Bottom of rock cut for conduit in trench shall be as required for the indicated depth of the conduit.
      b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Trench Width
Under 3 Feet	24 Inches, except where wider width is required by the multiple horizontal conduits.
3 to 10 Feet	36 Inches, except where wider width is required by the Drawings or directed for multiple horizontal conduits.

3.05 FIELD QUALITY CONTROL

A. Provide the Owner, Architect and CM with the recorded top of rock elevations. Prior to the performance of any rock removal operations obtain, in writing, that the Owner's Representative has reviewed the information and is in agreement with the measurements taken.

B. Notify the Owner's Representative at least 3 working days in advance of all phases of blasting operation.

3.06 CLEANING

A. Where footings and walls will rest entirely on rock, clean rock surfaces free of soil and loose rock.

END OF SECTION 312316.26

SECTION 312319
DEWATERING

PART 1 GENERAL

1.01 SCOPE

A. The work consists of the removal of surface water and ground water as necessary to perform construction required by the contract and in accordance with the specifications. It shall include: (1) constructing, installing, building and maintaining all necessary temporary water containment facilities, channels and diversions; (2) furnishing, installing and operating all necessary pumps, piping and other facilities and equipment; and (3) removing all such temporary works and equipment after their intended function is no longer required.

1.02 ACTION SUBMITTALS

A. Shop Drawings:
   1. For dewatering system, prepared by or under the supervision of a qualified professional engineer.
   2. Include plans, elevations, sections, and details.
   3. 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.
   4. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
   5. 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.

1.03 FIELD CONDITIONS

A. Project-Site Information:
   1. 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.
   2. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
   3. 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.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. 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.

B. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.

C. 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.

D. Prevent surface water from entering excavations by grading, dikes, or other means.

E. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.

F. Remove dewatering system when no longer required for construction.

G. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 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 created by dewatering operations.

B. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.

C. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

D. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

E. 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.

F. Provide temporary grading to facilitate dewatering and control of surface water.

G. Protect and maintain temporary erosion and sedimentation controls, during dewatering operations.

3.02 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.

3.03 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.

3.04 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.

3.05 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 312319

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SECTION 312323
FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling, and compacting for footings, slabs-on-grade, paving, site structures, utilities within the building, and sidewalks, site recreational facilities and general graded areas..

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 RELATED REQUIREMENTS

A. Document Ossining UFSD New Building and Site Improvements - Geotechnical Engineering Report: Geotechnical report; bore hole locations and findings of subsurface materials.
   1. Report prepared by Terracon Consultants - NY, Inc.

B. Section 015713 - Temporary Erosion and Sediment Control: Slope protection and erosion control.

C. Section 310519 - Geosynthetics for Earthwork.

D. Section 312200 - Grading: Removal and handling of soil to be re-used.

E. Section 312200 - Grading: Site grading.

F. Section 312316 - Excavation: Removal and handling of soil to be re-used.

G. Section 312316.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

H. Section 312316.26 - Rock Removal: Removal of rock during excavating.

I. Section 313700 - Riprap.

J. Section 334100 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.

1.03 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

1.04 REFERENCE STANDARDS

A. 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; 2026.

B. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.

C. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2012.

D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012 (Reapproved 2021).

E. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method; 2024.

F. 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 (Reapproved 2021).

G. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2015.

H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision.

I. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.

1.05 SUBMITTALS

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

B. Product Data for Manufactured Fill.

C. Product Data for Topsoil.

D. Materials Sources: Submit name of imported materials source.

E. 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.

F. Compaction Density Test Reports.

G. Testing Agency Qualification Statement.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

B. No recycled materials will be accepted. All fill to be 100% virgin material.

1.07 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.
   1. Site soils shall be protected from exposure to adverse weather conditions. Soils that are exposed to excessive moisture, ponding, precipitation, freezing, drying, or repeated wetting and drying may degrade in strength, stability, and suitability for construction.
   2. Soil deterioration resulting from exposure due to the Contractor's operations, sequencing, or failure to adequately protect the site soils shall **not** constitute grounds for additional compensation or charges for removal and replacement of unsuitable material. Any re-excavation, drying, stabilization, or replacement required as a result of such exposure shall be performed at the Contractor's own expense, and at no additional cost to the Owner.
   3. The Contractor is responsible for proper scheduling/sequencing of work and shall take the weather into account when so doing. Furthermore, the Contractor shall implement all appropriate measures, including but not limited to temporary drainage, tarping, covering, or prompt placement of fill, that may be necessary to maintain soil conditions suitable for construction.

1.08 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. No recycled materials will be accepted.

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:
      a. 3 inch sieve: 100 percent finer by weight.
      b. 1/4 inch sieve: 25 to 65 percent finer by weight.
      c. No. 40: 5 to 40 percent finer by weight.
      d. No. 200: 0 to 10 percent finer by weight.

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. Topsoil: Topsoil excavated on-site or imported in accordance wih Section 329219.
   1. Select.
   2. Graded.
   3. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.
   4. Acidity range (pH) of 5.5 to 7.5.
   5. Containing a minimum of 4 percent and a maximum of 25 percent inorganic matter.
   6. Complying with ASTM D2487 Group Symbol OH.

I. 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.

J. Planting Soil Mix: As described within the contract documents.

K. River Stone: As described within the contract documents.

L. NYSDOT No. 1 Crushed Stone (703-0201 Size 1) "Clean Washed #1 Stone": Complying with State of New York Department of Transportation (Section 703-0201) standard.

1. Meeting the Gradation Requirements for Size "1" in Table 703-4 within the NYSDOT Standard Specifications.

M. NYSDOT No. 2 Crushed Stone (703-0202 Size 2) "Clean Washed #2 Stone": Complying with State of New York Department of Transportation (Section 703-0201) standard.
   1. Meeting the Gradation Requirements for Size "2" in Table 703-4 within the NYSDOT Standard Specifications.

N. Underdrain Filters
   1. Type II (NYSDOT 605.1001): Complying with State of New York Department of Transportation (Item 605.1001 - Underdrain Filter Type II and Section 733-20) standard.

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 / alloawances 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 percnet 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 312200 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 312200 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 312323

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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 separatly 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 control ling erosion on their own.

H. The control of dust, erosion and sediment originating from construction operations is considered a critical responsibili ty 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 sedimenta tion 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 as shown on the Contract Drawings.

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 approxi mately 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 effec tively drain. Refill, reshape, and re-compact 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 312500

SECTION 313700
RIPRAP

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General riprap.

B. Geotextile filter fabric.

1.02 RELATED REQUIREMENTS

A. Section 310519 - Geosynthetics for Earthwork.

B. Section 312323 - Fill.

1.03 SUBMITTALS

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

B. Product Data:

C. Test Reports: Sieve analysis of bedding material.

PART 2 PRODUCTS

2.01 GENERAL RIPRAP

A. Riprap: Provide in accordance with State of New York Highways standards (Section 733-21 Stone Filling).
   1. Rip Rap Sizing as indicated on Drawings.

2.02 GEOTEXTILE FILTER FABRIC

A. See Section 310519.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify survey benchmarks and intended elevations for work are as indicated on plans.

B. Identify required lines, levels, contours, and datum locations.

C. Verify riprap areas are uncompromised with surface or groundwater.

D. Do not place riprap over frozen or spongy subgrade surfaces.

3.02 PREPARATION

A. Grade riprap areas to indicated elevations, allowing for riprap thickness. Remove organic materials and compact.

3.03 PLACEMENT

A. Perform work in accordance with New York State Department of Transportation Standards and Specifications for Rip Rap Stone.

B. Place in full course lifts starting at slope base and working uphill.

3.04 BEDDING OR SUBSTRATE CONTACT INSTALLATION

A. Geotextile Filter Fabric Placement:
   1. See Section 310519.
   2. Install in accordance with manufacturer's recommendations.
   3. Place over substrate in direction of water flow.
   4. Edges:
      a. Overlapped 2 feet (610 mm), minimum.
      b. Field sewn at 80 percent fabric strength, minimum.
   5. Secure fabric to prevent movement.

6. Repair or replace fabric damaged during installation.

3.05 GEOTEXTILE OR BEDDING CONTACT INSTALLATION

A. Geotextile Filter Fabric Placement:
   1. See Section 310519.
   2. Repair or replace fabric damaged during installation at no additional cost to the Owner.

END OF SECTION 313700

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 2 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 3 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 315000

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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 (Reapproved 2021).

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 2 - NYSDOT Pay Item Number 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. Areas indicated on drawings not specified as Bituminous Concrete Paving or Portland Cement Concrete Paving.
   1. Subbase Compacted Thickness: According to design drawings.
   2. Compact to 95 percent of maximum dry density.

D. Place course in maximum 4 inch layers and roller compact to specified density.

E. Level and contour surfaces to elevations and gradients indicated.

F. 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 321120

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.

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. 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 BASE COURSE

A. Place and compact 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 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 ¼ 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 321216

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SECTION 321313
CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks.

1.02 REFERENCE STANDARDS

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

A. Comply with applicable requirements of ACI 301.

2.02 FORM MATERIALS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
   1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.[**Do not use notched and bent forms.**]

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.03 REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M, Grade 80 (80,000 psi) yield strength; deformed billet steel bars; unfinished.

B. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.

C. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished finish.

2.04 CONCRETE MATERIALS

A. Concrete Materials: Provide in accordance with State of New York State Highways standards.

B. Fiber Reinforcement: Synthetic fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture; 1/2"to 3/4 " inch length.

2.05 ACCESSORIES

A. Curing Compound: ASTM C309, Type 1, Class A.

B. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
   1. Material: ASTM D1751, cellulose fiber.

C. Joint Sealants: Use Sikaflex Self Leveling Sealant or approved equivalent.

2.06 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
   1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

D. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.

E. Concrete Properties:
   1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; as indicated on the drawings or: 5000 psi.

2.07 MIXING

A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

B. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

A. See Section 321123 for construction of base course for work of this Section.

3.03 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.

3.04 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

A. Place reinforcement as indicated.

B. Interrupt reinforcement at contraction joints.

C. Place dowels to achieve pavement and curb alignment as detailed.

3.06 COLD AND HOT WEATHER CONCRETING

A. Follow recommendations of ACI 305R when concreting during hot weather.

B. Follow recommendations of ACI 306R when concreting during cold weather.

C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.07 PLACING CONCRETE

A. Coordinate installation of snow melting components.

B. Place concrete in accordance with ACI 304R.

C. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.

D. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

E. Apply surface retarder to all exposed surfaces in accordance with manufacturer's instructions.

3.08 JOINTS

A. Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.; Align curb, gutter, and sidewalk joints. Joint type and spacing as indicated on the drawings. Maximum spacing shall be 30 times the thickness of the slab.

B. Place 3/8 inch wide expansion joints at fiked objects and to separate paving from vertical surfaces and other components and in pattern indicated.
   1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
   2. Secure to resist movement by wet concrete.

C. Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.09 FINISHING

A. Area Paving: Light broom, texture perpendicular to pavement direction.

B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.

C. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.10 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.

B. Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - BSD Quality Requirements.
   1. Provide free access to concrete operations at project site and cooperate with appointed firm.

B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
   1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

3.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

END OF SECTION 321313

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SECTION 321623
SIDEWALKS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks.

B. Concrete wheelchair ramps.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

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 305R and ACI 306R 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" lenght, 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 321123 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.
   2. Uniformly add fiber reinforcement to concrete mix according to manufacturer's recommendations.

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 321623

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 PAINTED PAVEMENT MARKINGS

A. Comply with State of NYS DOT standards.

B. Comply with FHWA MUTCD.

C. Painted Pavement Markings: As indicated on drawings.
   1. Marking Paint: In accordance with AASHTO MP 24.
      a. Parking Lots: Yellow.
      b. Symbols and Text: White.
      c. Wheelchair Symbols: Provide blue and white.

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.

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. Apply in accordance with FHWA MUTCD standards.
   4. 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 321723

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 - Americans with Disabilities Act (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 ATBCB 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 321726

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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 selvage 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.

1. Fabric with Vinyl Privacy Slats - Locations are indicated on drawings.
    a. Slats to be bottom locking and provide at a minimum 75% visual screening.

b. Color: Brown or Black - Coordinate Color Selection with Owner.

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 r]adius 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 323113

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SECTION 323129
WOOD FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Wood fence systems.
   2. Wood gates.Fence posts, rails, pickets, and fasteners.
   3. Gate hardware and accessories.
   4. Concrete post footings.

1.02 RELATED SECTIONS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 312000 - Earth Moving.

C. Section 329119 - Landscape Grading.

D. Section 329219 - Seeding.

E. Section 329220 - Sodding.

1.03 REFERENCE STANDARDS

A. Comply with the Latest Editions of the following Standards:
   1. ASTM - Ameican Society for Testing and Materials; Current.
   2. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
   3. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019 (Reapproved 2025).
   4. ASTM D1761 - Standard Test Methods for Mechanical Fasteners in Wood and Wood-Based Materials; 2020 (Reapproved 2025).
   5. AWPA M4 - Standard for the Handling, Storage, Field Fabrication and Field Treatment of Preservative-Treated Wood Products; 2023.
   6. AWPA U1 - Use Category System: User Specification for Treated Wood; 2025.
   7. New York State Building Code (NYSBC), current adopted edition.

1.04 SUBMITTALS

A. Product Data:
   1. Manufacturer's literature for wood materials.
   2. Preservative treatment certification.
   3. Gate hardware information.

B. Shop Drawings:
   1. Fence layout showing alignment, dimensions, gate locations, and terminal conditions.
   2. Post spacing and footing details.
   3. Gate details and hardware schedule.

C. Samples:
   1. 12-inch long sample of each wood member type.
   2. Hardware finish samples upon request.

D. Certifications:
   1. Preservative treatment certificates.
   2. Lumber grading certificates.

1.05 QUALITY ASSURANCE

A. Lumber shall bear grade stamps from an accredited grading agency.

B. Preservative treatment shall be performed by a facility certified under AWPA requirements.

C. Installer shall have a minimum of three years documented experience installing wood fencing systems.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original bundles and packages.

B. Store lumber above ground and protected from moisture accumulation.

C. Protect treated wood from contamination and physical damage.

1.07 WARRANTY

A. Provide manufacturer's standard warranty on preservative-treated lumber.

B. Contractor shall warrant workmanship for one year from Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers include:

B. Hoover Treated Wood Products.

C. Culpeper Wood Preservers.

D. YellaWood.

E. Or approved equal.

2.02 MATERIALS

A. Wood Posts
   1. Pressure-treated Southern Pine, Douglas Fir, or approved species.
   2. AWPA UC4B treatment category minimum.Dimensions:
   3. Dimensions:
      a. Line Posts: As indicated on Contract Documents.
      b. End, Corner, and Gate Posts: As indicated on Contract Documents.
   4. Moisture content: Maximum 19 percent at fabrication.

B. Rails
   1. Pressure treated lumber.
   2. Nominal size: 2 x 4 minimum.
   3. AWPA UC4A treatment minimum

C. Fence Boards/Pickets
   1. Pressure-treated lumber or cedar as indicated.
   2. Nominal thickness: 1 inch minimum.
   3. Width: 4 to 6 inches as indicated on drawings.
   4. Smooth surfaced.

D. Fasteners
   1. Hot-dip galvanized in accordance with ASTM A153.
   2. Stainless steel fasteners may be used where specified.
   3. Nails: Ring shank or screw shank.
   4. Screws: Exterior-grade corrosion-resistant type.

2.03 CONCRETE

A. Concrete Footings:
   1. Minimum compressive strength: 3,000 psi at 28 days.Ready-mixed concrete complying with ASTM C94.

2.04 GATES

A. General
   1. Construct gates of materials matching adjacent fence.Provide diagonal bracing to prevent sagging.Fabricate for smooth operation.

B. Hardware
   1. Heavy-duty galvanized steel hinges.Positive latching mechanism.Padlock hasp where indicated.Cane bolts for double gates.Adjustable hinges for gates greater than 4 feet wide.

2.05 WOOD FENCE TYPES

A. Post-and-Rail / Split Rail Fence
   1. Two or three rail configuration.Rails securely fastened to posts using galvanized hardware.

2.06 FINISHES

A. Factory treatment as specified.

B. Field-applied stain or sealer where indicated.

C. Cut ends of treated members shall be field-treated in accordance with AWPA M4.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify property lines, easements, and fence alignment before installation.

B. Notify Owner's Representative of conditions that may adversely affect installation.

3.02 PREPARATION

A. Locate underground utilities prior to excavation.

B. Stake fence alignment and gate locations.

3.03 INSTALLATION

A. General
   1. Install fencing plumb, level, and true to line.
   2. Follow manufacturer's recommendations and approved Shop Drawings.

B. Posts
   1. Excavate post holes below frost depth or as shown on Drawings.
   2. Minimum post embedment:
      a. 36 inches.
      b. Greater depth where required by frost conditions.
   3. Hole diameter:
      a. Minimum three times post width.
      b. Not less than 12 inches.
   4. Set posts in concrete footings.
   5. Crown top of concrete to shed water.

C. Rails and Pickets
   1. Attach rails securely to posts.
   2. Install boards or pickets with consistent spacing.
   3. Align fence components uniformly.

D. Gates
   1. Install gates plumb and level.
   2. Adjust hardware to provide smooth operation.Install stops and latches for positive closure.

3.04 TOLERANCES

A. Maximum variation from plumb:1/4 inch in 8 feet.

B. Maximum variation in fence height:1/2 inch between adjacent panels.

3.05 FIELD QUALITY CONTROL

A. Inspect completed fence for:
   1. Alignment.Structural stability.
   2. Hardware operation.
   3. Damage to materials.

B. Replace damaged or defective components as necessary.

3.06 CLEANING

A. Remove debris and excess materials from site.

B. Restore disturbed areas to original condition.

3.07 PROTECTION

A. Protect completed work from damage until final acceptance.

B. Repair damage occurring prior to acceptance at no additional cost to Owner.

END OF SECTION 323129

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.
   4. Width: 24.5 inches.
   5. Height: 31.25 inches.
   6. Mounting: Surface mount per manufacturer's instructions with contractor provided stainless steel anchor bolts.
   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.
   2. Shape: Round.
   3. Diameter: 25 inches.

4. Height: 41 7/8 inches.
5. Inserts: Removable plastic containers for waste material.
6. Mounting: Surface mount per manufacturer's instructions with contractor provided stainless steel anchor bolts.
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 323300

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 325990

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SECTION 329119
LANDSCAPE GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Topsoil placement.

B. Finish grading.

1.02 RELATED REQUIREMENTS

A. Section 311000 - Site Clearing.

B. Section 312200 - Grading.

C. Section 312316 - Excavation.

D. Section 312323 - Fill.

E. Section 329219 - Seeding.

F. Section 329223 - Sodding.

1.03 REFERENCE STANDARDS

A. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision.

B. ASTM D5268 - Standard Specification for Topsoil Used for Landscaping and Construction Purposes; 2023.

1.04 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with State of New York, Highway Department standards.

1.06 FIELD CONDITIONS

A. Place topsoil during dry weather.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: Comply with ASTM D5268.

B. Topsoil: Topsoil excavated on-site.
   1. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.
   2. Acidity Range (pH): 5.5 to 7.5.
   3. Comply with ASTM D2487 Group Symbol OH.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify grading and intended elevations are as indicated on drawings.

B. Verify absence of standing or ponding water.

3.02 PREPARATION

A. Protect site features to remain, including bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size.

C. Scarify surface to depth of 6 inches.

D. Clear site; see Section 311000.

E. Grade substrate, see Section 312200.

3.03 TOPSOIL PLACEMENT

A. Uniformly distribute and spread topsoil.

B. Place topsoil in areas where seeding, sodding, and planting as indicated on drawings.

C. Topsoil Thickness: Place as indicated on drawings.

3.04 FINISH GRADING

A. Maintain profiles and contour of subgrade.

B. Maintain uniform topsoil thickness.

C. Lightly compact placed topsoil.

D. Apply seed, see Section 329219.

E. Apply sod; see Section 329223.

3.05 TOLERANCES

A. Topsoil Thickness: 1/2 inch plus/minus.

3.06 CLEANING

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

B. Remove unused topsoil. Grade stockpile area to prevent standing water.

3.07 PROTECTION

A. Protect from stormwater runoff and subsequent construction operations.

B. Do not permit traffic until established.

END OF SECTION 329119

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 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. All lawn areas with slopes less than 3:1 are to receive 6" of approved topsoil and be seeded with the Lawn Areas Seed Mix (see landscape plan).
   2. All non-landscaped earthen areas with slopes of 3:1 or steeper are to receive 6" of approved topsoil and be seeded with the Naturalized Areas Seed Mix (see landscape plan).
   3. Where noted, bioretention areas are to receive a permeable sand-based soil as specified in the Typical Bioretention Area Cross Section and seeded with the Bioretention Areas Seed Mix (see landscape plan).
   4. A portion of lawn areas are to be sodded (see landscape plan).

2.02 SOIL MATERIALS

A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site or imported material; 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 phosporus 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 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 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. Maintain clear of shrubs and trees.

E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

F. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

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. Maintain clear of shrubs and trees.

D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

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. Provide maintenance of seeded areas for 12 months from Date of Substantial Completion.

D. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. 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 329219

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SECTION 329223
SODDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fertilizing.

B. Sod installation.

C. Maintenance.

1.02 DEFINITIONS

A. Weeds: Includes 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.

1.03 REFERENCE STANDARDS

A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding; 2006.

1.04 SUBMITTALS

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

B. Certificate: Certify grass species and location of sod source.

C. Certificate: Certify fertilizer and herbicide mixture approval by authority having jurisdiction.

1.05 QUALITY ASSURANCE

A. Sod Producer: Company specializing in sod production and harvesting with minimum five years experience, and certified by the State of New York.

B. Installer Qualifications: Company approved by the sod producer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver sod on pallets. Protect exposed roots from dehydration.

B. Do not deliver more sod than can be laid within 24 hours.

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 fertilizer and herbicide mixture.

2.02 MATERIALS

A. Sod: TPI (SPEC), Certified Turfgrass Sod quality; cultivated grass sod; type consistent with lawn seed mix noted on the landscape plan; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft. Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
   1. Thickness: "Thick" sod, minimum 1 inch and maximum 1-3/8 inch topsoil base.

B. 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.

C. Fertilizer: commercial-grade complete fertilizer of neutral character; 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.

D. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

2.03 ACCESSORIES

A. Wood Pegs: Softwood, sufficient size and length to ensure anchorage of sod on slope.

B. Wire Mesh: Interwoven hexagonal metal wire mesh of 2 inch size.

C. Edging: Galvanized steel.

2.04 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 soil base is ready to receive the work of this section.

3.02 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to installation of sod.

C. Apply fertilizer no more than 48 hours before laying sod.

D. Mix thoroughly into upper 2 inches of topsoil.

E. Lightly water to aid the dissipation of fertilizer.

3.03 LAYING SOD

A. Moisten prepared surface immediately prior to laying sod.

B. Lay sod immediately after delivery to site to prevent deterioration.

C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.

D. Where new sod adjoins existing grass areas, align top surfaces.

E. Where sod is placed adjacent to hard surfaces, such as curbs, pavements, etc., place top elevation of sod 1/2 inch below top of hard surface.

F. On slopes 6 inches per foot and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.

G. Prior to placing sod, on slopes exceeding 8 inches per foot or where indicated, place wire mesh over topsoil. Securely anchor in place with wood pegs sunk firmly into the ground.

H. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.

I. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

3.04 MAINTENANCE

A. Provide maintenance at no extra cost to Owner; Owner will pay for water.

B. Provide maintenance of sodded areas for 12 months from Date of Substantial Completion.

C. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.

D. Neatly trim edges and hand clip where necessary.

E. Immediately remove clippings after mowing and trimming.

F. Water to prevent grass and soil from drying out.

G. Roll surface to remove irregularities.

H. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

I. Immediately replace sod to areas that show deterioration or bare spots.

J. Protect sodded areas with warning signs during maintenance period.

END OF SECTION 329223

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SECTION 329300
PLANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil.

B. Planting soil 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 A300 Part 1 - American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices (Pruning); 2017.

B. ANSI/AHIA Z60.2 - American Standard for Nursery Stock; 2025.

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 or rise above 90 degrees F.

B. Do not install plant life when wind velocity exceeds 30 mph.

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. A uniform mixture of 1 part peat and 3 parts topsoil by volume.

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 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 three times wider than the plant root ball and to a depth minimally equal to the height of the plant root ball plus 4".

3.03 PLACING PLANTING SOIL

A. Spread planting soil to a minimum depth of 4 inches over area to be planted. Rake smooth.

B. Place planting soil during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from planitng soil while spreading.

D. Grade planting soil to eliminate rough, low or soft areas, and to ensure positive drainage.

E. Grade and compact planting soil so that there is a platform for the plant root ball slightly above the surrounding tree pit.

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 of topsoil.

D. Lightly water to aid the dissipation of fertilizer.

3.05 PLANTING

A. Place plants for best appearance.

B. Set plants vertical so that a 12" radius of root flare is exposed. Adjust height of compacted planting soil below root ball if required.

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 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 layers. Maintain plant life in vertical position.

F. Final root ball height shall allow for 4" of mulch while maintaining a 12" radius of exposed root flare. If root ball is too high or too low, adjust depth of planting pit as required.

G. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

H. Install 4" of mulch over entire tree pit or planting bed, keep clear of plant stems.

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; 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 329300

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 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 330110.58

SECTION 330130.87
CHANGING ELEVATIONS OF MANHOLES AND DRAINAGE STRUCTURES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM C32 - Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale); 2023.

B. ASTM C139 - Standard Specification for Dry-Cast Concrete Masonry Units for Construction of Catch Basins and Manholes; 2025.

C. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2025a.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork: Division 31.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sewer Brick: ASTM C32, Grade MS.

B. Concrete Masonry Units: ASTM C139.

C. Mortar: ASTM C270, Type M.

PART 3 EXECUTION

3.01 ADJUSTMENTS

A. Raise or lower the existing frames, covers and gratings of manholes, and drainage structures to the grades fixed by the Owner’s Representative.

B. Parge exterior surface with mortar when brick or masonry units are added or when the exterior surface is disturbed.

C. Replace frames, covers or gratings damaged during the Work of the Contract.

END OF SECTION 330130.87

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SECTION 330505.31
HYDROSTATIC TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Hydrostatic testing of pressurized water piping.

1.02 REFERENCE STANDARDS

A. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.

B. American Water Works Association:
   1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.03 SUBMITTALS

A. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.

B. Manufacturer’s installation instructions shall be provided along with product data.

C. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

D. Submit following items prior to start of testing:
   1. Testing procedures.
   2. List of test equipment.
   3. Testing sequence schedule.
   4. Provisions for disposal of flushing and test water.
   5. Certification of test gage calibration.

E. Test and Evaluation Reports: Indicate results of piping tests.

F. Qualifications Statement:
   1. Submit qualifications for applicator.

1.04 QUALITY ASSURANCE

A. Perform Work according to AWWA standards as well as all requried local, county, state and federal requirements.

B. Maintain a copy of each standard affecting Work of this Section on Site.

1.05 QUALIFICATIONS

A. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience.

PART 2 PRODUCTS

2.01 HYDROSTATIC TESTING

A. Equipment:
   1. Pressure pump.
   2. Pressure hose.
   3. Water meter.
   4. Test connections.
   5. Pressure relief valve.
   6. Pressure Gage: Calibrated to 0.1 psi.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping is ready for testing and notify the Owner’s Representative.

B. Verify that trenches are backfilled.

C. Verify that pressure piping thrust restraints have been installed.

3.02 FIELD QUALITY CONTROL

A. Notify and coordinate with the Owner's Representative a minimum of 48-hours before testing.

B. Testing of Pressure Piping:
   1. Test system according to AWWA C600 and following:
      a. Hydrostatically test each portion of pressure piping, including valved section, at 1.5 times working pressure of piping, based on elevation of lowest point in piping corrected to elevation of test gage.
      b. Conduct hydrostatic testing for at least two hours.
      c. Slowly fill with water portion of piping to be tested, expelling air from piping at high points.
      d. Install corporation cocks at high points.
      e. Close air vents and corporation cocks after air is expelled.
      f. Raise pressure to specified test pressure.
      g. Observe joints, fittings, and valves undergoing testing.
      h. Remove and renew cracked pipes, joints, fittings, and valves that show visible leakage.
      i. Retest.
      j. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
      k. Maintain pressure within plus or minus 5.0 psi of test pressure.
      l. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of testing.
      m. Compute maximum allowable leakage using following formula:
         1) L = SD x sqrt(P)/C.
         2) L = testing allowance, gph.
         3) S = length of pipe tested, feet.
         4) D = nominal diameter of pipe, inches.
         5) P = average test pressure during hydrostatic testing, psig.
         6) C = 148,000.
         7) If pipe undergoing testing contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each pipe size.
   2. If testing of piping indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within acceptable limits. Coordinate re-testing with the Owner's Representative.
   3. Correct visible leaks regardless of quantity of leakage.

END OF SECTION 330505.31

SECTION 330505.36
VACUUM TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Vacuum testing of manholes.

1.02 REFERENCE STANDARDS

A. ASTM - Ameican Society for Testing and Materials; Current.
   1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

1.03 SUBMITTALS

A. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.

B. Manufacturer’s installation instructions shall be provided along with product data.

C. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

D. Submit following items prior to start of testing:
   1. Testing procedures.
   2. List of test equipment.
   3. Testing sequence schedule.
   4. Provisions for disposal of flushing and test water.
   5. Certification of test gage calibration.

E. Test and Evaluation Reports: Indicate results of manhole tests.

F. Qualifications Statement:
   1. Submit qualifications for applicator.

1.04 QUALITY ASSURANCE

A. Perform Work according to ASTM standards.

B. Maintain copy of each standard affecting Work of this Section on Site.

1.05 QUALIFICATIONS

A. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience.

PART 2 PRODUCTS

2.01 VACUUM TESTING

A. Equipment:
   1. Vacuum pump.
   2. Vacuum line.
   3. Vacuum Tester Base:
      a. Compression band seal.
      b. Outlet port.
   4. Shutoff valve.
   5. Stopwatch.
   6. Plugs.
   7. Vacuum Gage: Calibrated to 0.1 inch. Hg.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that manholes are ready for testing.

B. Verify that manholes are backfilled.

3.02 FIELD QUALITY CONTROL

A. Notify and coordinate with the Owner's Representative a minimum of 48-hours before testing.

B. Manhole Testing:
   1. Test manholes with manhole frame set in place.
   2. Vacuum Testing:
      a. Comply with ASTM C1244.
      b. Plug pipe openings; securely brace plugs and pipe.
      c. Inflate compression band to create seal between vacuum base and structure.
      d. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10 inch. Hg.
      e. Close valve.
      f. Manhole Test Duration in Seconds:
         1) Manhole Diameter of 4 Feet: 60.
         2) Manhole Diameter of 5 Feet: 75.
         3) Manhole Diameter of 6 Feet: 90.
      g. Record vacuum drop during test period.
      h. If vacuum drop is greater than 1 inch. Hg during testing period, repair and retest manhole.
      i. If vacuum drop of 1 inch. Hg does not occur during test period, manhole is acceptable; discontinue testing.
      j. If vacuum test fails to meet 1-in. Hg drop in specified time after repair, repair and retest manhole.
   3. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria. Coordinate re-testing with the Owner's Representative.
   4. Repair visible leaks regardless of quantity of leakage.

END OF SECTION 330505.36

SECTION 330505.41
AIR TESTING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

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

1.02 SUMMARY

A. Section Includes: Low-pressure air testing of gravity sewer piping.

1.03 SUBMITTALS

A. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.

B. Manufacturer’s installation instructions shall be provided along with product data.

C. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

D. Submit following items prior to start of testing:
   1. Testing procedures.
   2. List of test equipment.
   3. Testing sequence schedule.
   4. Provisions for disposal of flushing and test water.
   5. Certification of test gage calibration.

E. Test and Evaluation Reports: Indicate results of piping tests.

F. Qualifications Statement:
   1. Submit qualifications for applicator.

1.04 QUALITY ASSURANCE

A. Perform Work according to ASTM standards.

1.05 QUALIFICATIONS

A. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience.

PART 2 PRODUCTS

2.01 AIR TESTING

A. Equipment:
   1. Air compressor.
   2. Air supply line.
   3. Shutoff valves.
   4. Pressure regulator.
   5. Pressure relief valve.
   6. Stopwatch.
   7. Plugs.
   8. Pressure Gage: Calibrated to 0.1 psi.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping is ready for testing.

B. Verify that trenches are backfilled.

C. Satisfactorily complete lamping of gravity piping prior to testing.

3.02 PREPARATION

A. Lamping:
   1. Lamp gravity piping after flushing and cleaning.
   2. Perform lamping operation by shining light at one end of each pipe section between manholes.
   3. Observe light at other end.
   4. Pipe not installed with uniform line and grade will be rejected.
   5. Remove and reinstall rejected pipe sections.
   6. Clean and lamp until pipe section is installed to uniform line and grade.

B. Plugs:
   1. Plug outlets, wye branches, and laterals.
   2. Brace plugs to resist test pressures.

3.03 FIELD QUALITY CONTROL

A. Notify and coordinate with the Owner's Representative a minimum of 48-hours before testing.

B. Low-Pressure Air Testing:
   1. Test each reach of gravity sewer piping between manholes. Owner's Representative shall be present for all testing.
   2. Introduce air pressure slowly to approximately 4 psig.
   3. Determine ground water elevation above spring line of piping.
   4. For every foot of ground water above spring line of piping, increase starting air test pressure by 0.43 psi.
   5. Do not increase pressure above 10 psig.
   6. Allow pressure to stabilize for at least five minutes.
   7. Adjust pressure to 3.5 psig or to increased test pressure as determined above when ground water is present.
   8. Do not make allowance for laterals.
   9. Minimum Testing Duration in Minutes Per 100 Feet:
      a. Pipe Size 3 Inches: 0.2.
      b. Pipe Size 4 Inches: 0.3.
      c. Pipe Size 6 Inches: 0.7.
      d. Pipe Size 8 Inches: 1.2.
      e. Pipe Size 10 Inches: 1.5.
      f. Pipe Size 12 Inches: 1.8.
      g. Pipe Size 15 Inches: 2.1.
      h. Pipe Size 18 Inches: 2.4.
      i. Pipe Size 21 Inches: 3.0.
      j. Pipe Size 24 Inches: 3.6.
      k. Pipe Size 27 Inches: 4.2.
      l. Pipe Size 30 Inches: 4.8.
      m. Pipe Size 33 Inches: 5.4.
      n. Pipe Size 36 Inches: 6.0.
   10. Record drop in pressure during testing period.
   11. If air pressure drops more than 1.0 psi during testing period, piping has failed.
   12. If 1.0-psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.
   13. If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes. Coordinate repairs with the Owner's Representative.

14. If unsatisfactory testing results are achieved, make necessary repairs and retest until result meets criteria. Coordinate repairs with the Owner's Representative.
15. Repair visible leaks regardless of quantity of leakage. Coordinate repairs with the Owner's Representative.

END OF SECTION 330505.41

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SECTION 330505.43
MANDREL TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Deflection testing of plastic sewer piping.

1.02 REFERENCE STANDARDS

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

B. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings; 2022.
   1. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

1.03 SUBMITTALS

A. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.

B. Manufacturer's installation instructions shall be provided along with product data.

C. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

D. Submit following items prior to start of testing:
   1. Testing procedures.
   2. List of test equipment.
   3. Testing sequence schedule.
   4. Provisions for disposal of flushing and test water.
   5. Certification of test gage calibration.
   6. Deflection mandrel drawings and calculations.

E. Test and Evaluation Reports: Indicate results of piping tests.

PART 2 PRODUCTS

2.01 DEFLECTION TESTING

A. Equipment:
   1. Properly sized rigid ball.
   2. Pull/retrieval ropes.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping is ready for testing.

B. Verify that trenches are backfilled.

3.02 PREPARATION

A. Plugs:
   1. Plug outlets, wye branches, and laterals.
   2. Brace plugs to resist test pressures.

3.03 FIELD QUALITY CONTROL

A. Deflection Testing of Plastic Sewer Piping:
   1. Notify and coordinate with the Owner's Representative a minimum of 48-hours before testing.

2. Perform vertical ring deflection testing on PVC and ABS sewer piping after backfilling has been in place for at least 30 days, but not longer than 12 months.
3. Allowable maximum deflection for installed plastic sewer pipe is no greater than five percent of original vertical internal diameter.
4. Perform deflection testing using properly sized rigid ball.
5. Rigid Ball Diameter:
   a. Not less than 95 percent of base or average ID of pipe.
   b. Pipe Diameter: Comply with ASTM D2122.
6. Perform testing without mechanical pulling devices.
7. Locate, excavate, replace, and retest piping that exceeds allowable deflection.

END OF SECTION 330505.43

SECTION 330561
CONCRETE MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast concrete manholes.

B. Grade adjustments.

C. Frames and covers.

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 dawings.

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. Frame and Cover: ASTM A48/A48M Class 30B cast iron construction, machined flat bearing surface.

B. Cover: Removable,cover design; cover molded with identifying name.

C. Proof Load: Heavy duty.
   1. Manufacturers:
      a. Syracuse Castings
      b. Neenah Foundry.
      c. Jordan Iron Works.
      d. Substitutions: See Section 016000 - Product Requirements.

D. Steps: Formed galvanized steel rungs; 3/4 inch diameter. Formed integral with manhole sections.

2.03 CONFIGURATION

A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female dry joints; sleeved to receive pipe sections.

B. Shape: Cylindrical.

C. Clear Inside Dimensions: As indicated.

D. Design Depth: As indicated.

E. Clear Lid Opening: As indicated.

F. Pipe Entry: Provide openings as indicated.

G. Steps: 12 inches wide, 16 inches on center vertically, set into manhole wall.

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. Lay brick or masonry units uniformly on mortar bed with full head joints, running bond. Top with mortar, plumb and level.
   2. Place adjacent materials tight, and smooth following design grades.

D. Frames and Covers:
   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 330561

SECTION 331416
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water pipe.
B. Pipe valves.
C. Fire hydrants.
D. Water Meters
E. Meter Vaults/Structures

1.02 RELATED REQUIREMENTS

A. Section 033000 - CAST-IN-PLACE CONCRETE: Concrete for thrust restraints.
B. Section 099113 - Exterior Painting.
C. Section 211100 - Facility Fire-Suppression Water-Service Piping.
D. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.
E. Section 330110.58 - Disinfection of Water Utility Piping Systems: Disinfection of site service utility water piping.

1.03 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; 2021.
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; 2022.
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; 2024.
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; 2026.
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; 2025.
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.

1.04 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. Coordinate with Local Water Utility for scheduling of connection to Water Main. Excavation to be provided by contractor, Utility to provide and install valves and tee for connection as shown on drawings.

1.05 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.

D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with State Department of Health, County Health Department and local utility provider requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

1.08 WARRANTY

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

PART 2 PRODUCTS

2.01 WATER PIPE

A. Manufacturers:
   1. US Pipe and Foundary; https://www.uspipe.com/
   2. American Cast Iron Pipe Company; https://american-usa.com/.
   3. McWane Ductile; https://www.mcwaneductile.com/.
   4. JM Eagle; https://www.jmeagle.com/
   5. Substitutions: See Section 016000 - Product Requirements.

B. 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.

C. 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.

D. 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.

E. 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.
   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.

F. Polyethylene Pipe: AWWA C901:
   1. Fittings: AWWA C901, molded or fabricated.
   2. Joints: Compression.

G. 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 as indicated on the drawings .

C. Meter: Size and type as indicated on the drawings .

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, HYDRANTS, BACKFLOW PREVENTERS

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. Preform 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 331416

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SECTION 331900
WATER UTILITY METERING EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Design Intent
   1. The system shall provide long-term utility revenue-grade measurement of potable water consumption utilizing solid-state ultrasonic technology having no moving measuring components.
   2. The completed installation shall be:
      a. Accurate.
      b. Reliable.
      c. Low maintenance.
      d. Utility compatible (Village of Ossining Water Department).
      e. Accessible for servicing.
      f. Suitable for operation in a flooded meter vault environment.

B. Basis of Design
   1. Basis of design shall be:
      a. Neptune MACH 10 Ultrasonic Water Meter
      b. Other manufacturers may be considered as Approved Equals in accordance with Contract Documents provided all specified performance requirements are fully satisfied.

C. Section Includes:
   1. Ultrasonic flow meters.
   2. Transmitters.
   3. Indicators.
   4. Recorders.
   5. Integrators.

D. Related Requirements:
   1. Section 330563 - Concrete Vaults and Chambers: Requirements for meter boxes used to access and protect meter installation.
   2. Section 331416 - Site Water Utility Distribution Piping: Requirements for domestic water piping from building to utility source.

1.02 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.03 REFERENCE STANDARDS

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

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

C. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

D. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings; 2015 (Reapproved 2021).

E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2024.

F. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2024.

G. AWWA C702 - Cold-Water Meters -- Compound Type; 2024.

H. AWWA C704 - Propeller-Type Meters for Waterworks Applications; 2024.

I. AWWA C707 - Encoder-Type Remote-Registration Systems for Cold-Water Meters; 2022.

J. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012, with Addendum (2018).

K. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

L. NSF 372 - Drinking Water System Components - Lead Content; 2024.

M. American Society of Mechanical Engineers:
   1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. ASME PTC 19.5 - Flow Measurement.

N. American Water Works Association:
   1. AWWA C700 - Cold-Water Meters - Displacement Type, Metal Alloy Main Case.
   2. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
   3. AWWA C702 - Cold-Water Meters - Compound Type.
   4. AWWA C704 - Propeller-Type Meters for Waterworks Applications.
   5. AWWA C707 - Encoder-Type Remote-Registration Systems for Cold-Water Meters.
   6. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

O. ASTM International:
   1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings.

P. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

Q. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

1.04 PREINSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this Section.

1.05 SUBMITTALS

A. Manufacturer’s installation instructions shall be provided along with product data.

B. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

C. Product Data: Submit manufacturer information for water meters and accessories.

D. Manufacturer's Certificate: Certify that water meters meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports:
   1. Certify that equipment has been installed according to manufacturer's instructions.
   2. Indicate activities on Site, adverse findings, and recommendations.

I. Qualifications Statements:
   1. Submit qualifications for manufacturer and installer.
   2. Submit manufacturer's approval of installer.

1.06 CLOSEOUT SUBMITTALS

A. Section 017716 - Contract Closeout: Requirements for submittals.

B. Project Record Documents: Record actual locations of water meters.

1.07 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

B. Perform Work according to NYSDOH ???_____??? standards.

C. Maintain one copy of each document on Site.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three ???_____??? years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three ???_____??? years' documented experience and approved by manufacturer.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 016500 - Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Furnish five ???_____???-year manufacturer's warranty for water meters.

PART 2 PRODUCTS

2.01 POSITIVE DISPLACEMENT METERS

A. Manufacturers:
   1. Badger Meter, (800) 616-3837, 4545 West Brown Deer Rd., Milwaukee, WI 53223.
   2. Neptune Technology Group, (334) 283-6555, 1600 Alabama Highway 229, Tallassee, AL 36078.
   3. Sensus, (914) 323-5700, 1 International Drive, Rye Brook, NY 10573.
   4. Approved equivalent.

B. Description:
   1. Brass body turbine meter with magnetic drive register.
   2. Comply with AWWA C700.
   3. Type: Positive displacement disc.
   4. Case Material: Bronze.
   5. Bottom Cap:
      a. Material: Cast iron.
      b. Type: Frost proof; breakaway.
   6. Register: Hermetically sealed.
   7. Remote Reading: Comply with AWWA C707.

C. Performance and Design Criteria:
   1. Service: Cold water, 122 degrees Fahrenheit.
   2. Nominal Flow Rate: ???_____??? gpm.
   3. Pressure Drop at Nominal Flow: ???_____??? psig.
   4. Maximum Flow Rate: ???_____??? gpm.
   5. Maximum Operating Pressure: ???_____??? psig.
   6. Accuracy: 1.5 ???_____??? percent.
   7. Maximum Counter Reading: 10 MG.
   8. Pipe Size: 1/2 ???_____??? inch.

2.02 MAGNETIC FLOW METERS

A. Manufacturers:
   1. Badger Meter, (800) 616-3837, 4545 West Brown Deer Rd., Milwaukee, WI 53223.
   2. Northeast Controls, (518) 664-6600, 3 Enterprise Avenue, Clifton Park, NY 12065.
   3. Approved equivalent.

B. Description:
   1. Low-frequency, electromagnetic induction-type flowmeter, producing a linear signal directly proportional to flow rate, consisting of flow tube, signal cable, and transmitter.
   2. Flow Rate Range: ???_____??? to ???_____??? gpm.
   3. Accuracy: Plus or minus 1 percent of actual flow rate over a 10:1 range.
   4. Provide adjustment for zero and span.
   5. Size: As indicated on Drawings.

C. Flow Tube:
   1. Materials: Type ???_____??? stainless steel ???_____???, with polyurethane ???_____??? liner.
   2. Length: As indicated on Drawings.
   3. End Connections: Flanged; ASME B16.1 ; carbon steel.

D. Electrodes:
   1. Material: Type 316L stainless steel.
   2. Self-cleaning.

E. Accessories:
   1. Automatic, non-mechanical electrode cleaning system without taking meter out of service.
   2. Cable: Between transmitter and receiver.

2.03 ULTRASONIC FLOW METERS

A. Manufacturers:
   1. Badger Meter, (800) 616-3837, 4545 West Brown Deer Rd., Milwaukee, WI 53223.
   2. Omega Engineering, Inc., (203) 359-1660, 800 Connecticut Ave. Suite 5N01, Norwalk, CT 06854
   3. Approved equivalent.

B. Description:
   1. Clamp separate and nonintrusive transmitting and receiving transducers to outside of process pipe.
   2. Flow Rate Range: ???_____??? to ???_____??? gpm.
   3. Ambient Operating Temperature Range:
      a. Indoors: ???_____??? degrees F.
      b. Outdoors: ???_____??? degrees F

C. Output Signal:
   1. 4 to 20 mA dc.

2. Linear with flow rate.
3. Linearity: Plus or minus 0.5 percent.
4. Repeatability: 0.1 percent under simulated flow.
5. Long-Term Drift: Less than 0.1 percent.

2.04 VENTURI FLOW METERS

A. Manufacturers:
1. Northeast Controls, (518) 664-6600, 3 Enterprise Avenue, Clifton Park, NY 12065.
2. Rosemount Emerson, 8000 West Florissant Avenue, P.O. Box 4100, St. Louis , MO 63136.
3. Approved equivalent.

B. Description:
1. Designed for potable water service with at least 90 percent head recovery.
2. Type: Differential.
3. Comply with ASME PTC 19.5.
4. Size: As indicated on Drawings.
5. Flow Rate Range: ???_____??? to ???_____??? gpm.
6. End Connections:
   a. Flanged.
   b. Comply with ASME B16.1.

C. Materials:
1. Body: Cast iron; ASTM A126 ; Grade B ???_____???.
2. Throat Section and Vent Bushing: Bronze; ASTM B61 ???_____???.
3. Interior Water Passages: Lined with anti-stick material.

D. Holding Flange:
1. Material: Carbon steel ???_____???.
2. Provide integral pressure taps.

E. Cleaning Provisions:
1. Provide manual vent cleaners on tube.
2. Provide water purge system and matched assemblies of piping, valves, rotameters, and fittings.

2.05 TRANSMITTERS:

A. Description:
1. Output:
   a. 4 to 20 mA dc analog signal.
   b. Accuracy: Plus or minus ???_____??? percent of full scale.
2. Transmitter Communication Interface: PROFIBUS ???_____???.
3. Communication Firmware and Software: ???_____???.
4. Housing Material: Cast aluminum.

B. Human-Machine Interface:
1. Touch-screen programming, functioning through enclosure window without opening enclosure.
2. Display:
   a. Size: Four lines by 16 characters.
   b. Type: Backlit LCD.
   c. User-selectable engineering units.
   d. Readout of diagnostic error messages.

C. Mounting:

1. Integral or remote mounting up to ???_____??? feet from meter.
2. Mounting Locations Less Than 4 Feet Above Grade: Furnish stainless-steel mounting posts.

D. Accessories:
1. Current signal output simulation.
2. Empty pipe detection.
3. Self-diagnostics.
4. Automatic zero adjustment.
5. Stainless-steel sunshield.
6. Signal Cable: Furnished by flow meter manufacturer.

2.06 INDICATORS

A. Manufacturers:
1. SeaMetrics, Inc., (800) 975-8153, 19026 72nd Ave. S, Kent, WA 98032.
2. Approved equivalent.

B. Description:
1. Integrally mounted in transmitter housing.
2. Scale: Graduated.
3. Length: ???_____??? inches.
4. Units: gpm.
5. Mounting: Wall.

2.07 RECORDERS

A. Manufacturers:
1. Foxboro, (866) 746-6477, 33 Commercial Street, Foxboro, MA 02035.
2. Honeywell International Inc., (518) 452-6646, 1 Executive Centre Dr, Albany, NY 12203.
3. Approved equivalent.

B. Description:
1. Minimum Diameter: 10 inches.
2. Rotation Cycle: Once per day.
3. Drive Mechanism:
a. Synchronous motor.
b. ???_____??? V ac, ???_____??? Hz.

2.08 INTEGRATORS

A. Manufacturers:
1. Precision Digital Corporation, (800) 343-1001, 233 South St, Hopkinton, MA 01748
2. SeaMetrics, Inc., (800) 975-8153, 19026 72nd Ave. S, Kent, WA 98032.
3. Approved equivalent.

B. Description:
1. Totalize flow in specified units.
2. Interface with specified flow meter assembly.
3. Accuracy: Plus or minus 0.25 percent of full scale.

2.09 OPERATION

A. Control Power:
1. Wiring: As specified in Section 260503 - Equipment Wiring Connections.
2. Voltage: 120 V ac, single phase, 60 Hz.
3. Furnish local transformers as required.

B. Enclosures: NEMA 4 ???_____???.

2.10 METER BOXES

A. As specified in Section 330563 - Concrete Vaults and Chambers ???_____-_____???.

2.11 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of meters.

B. Test meters according to AWWA M6.

C. Director's Inspection:
   1. Make completed flow meter available for inspection at manufacturer's factory prior to packaging for shipment.
   2. Notify Director's Representative at least seven ???_____??? days before inspection is allowed.

D. Director's Witnessing:
   1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
   2. Notify Director's Representative at least seven ???_____??? days before inspections and tests are scheduled.

E. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building service connections and municipal utility water main sizes, locations, and elevations are as indicated on Shop Drawings.

3.02 PREPARATION

A. Before attaching meter, ensure that pipe ends are deburred, square, and plumb and that scale and dirt on inside and outside of piping has been removed.

B. Prepare pipe connections to equipment with flanges or unions, as appropriate.

C. Protect and support existing distribution piping as Work progresses.

3.03 INSTALLATION

A. Meters:
   1. Install meters according to AWWA M6, with isolating valves on inlet and outlet.
   2. Provide full line-size bypass with globe valve.

B. Meter Boxes:
   1. As specified in Section 330563 - Concrete Vaults and Chambers ???_____-_____???.

3.04 FIELD QUALITY CONTROL

A. Testing:
   1. Test and calibrate flow meter to demonstrate specified accuracy requirements.
   2. Test meters according to AWWA M6.

B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than ???_____??? days on Site for installation, inspection, startup, field testing, and instructing Facility personnel in maintenance of equipment. Coordinate with Director's Representative.

C. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.05 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Facility personnel.

3.06 ATTACHMENTS

A. Water Meters:
1. FE/FIT-463:
   a. Manufacturer: ???_____???.
   b. Model: ???_____???.
   c. Location: ???_____???.
   d. Type: ???_____???.
   e. Size: ???_____???.
   f. Flow Rate Range: ???_____???.
   g. Output Signal: ???_____???.
   h. Meter Box Depth: ???_____??? inches
2. FE/FIT-464:
   a. Manufacturer: ???_____???.
   b. Model: ???_____???.
   c. Location: ???_____???.
   d. Type: ???_____???.
   e. Size: ???_____???.
   f. Flow Rate Range: ???_____???.
   g. Output Signal: ???_____???.
   h. Meter Box Depth: ???_____??? inches

END OF SECTION 331900

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 Soil 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. Joint Seals: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.

K. 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 toASTM 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 333113

SECTION 334100
SUBDRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Building Perimeter, Retaining Wall, and Under-Slab , in Parking Lot or Beneath Curbing. Drainage Systems.

B. Filter aggregate and fabric and bedding.

1.02 REFERENCE STANDARDS

1.03 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 indicted on te 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 or bedding stone if shown on the drawings .

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 or as indicated on the drawings .

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 334100

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 End Sections
   1. Galvanized steel.
   2. Flat strap connector with galvanized bolt.

D. Stormwater Pipe Anchors
   1. Cast in Place concrete as indicated on drawings.

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 1**50** 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 334211

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SECTION 334213
STORMWATER CULVERTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe culvert, joints and accessories.

B. Bedding and slope protection at pipe end.

1.02 RELATED REQUIREMENTS

A. Section 033000 - CAST-IN-PLACE CONCRETE: Concrete grout fill to adjacent construction.

B. Section 312316 - Excavation: Excavating of trenches.

C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

A. ASTM A929/A929M - Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe; 2024.

B. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe; 2020 (Reapproved 2025).

PART 2 PRODUCTS

2.01 CULVERT PIPE, GENERAL

A. Regulatory Requirements: Comply with applicable code for materials and installation of the work of this section.

2.02 STEEL CULVERT PIPE

A. Corrugated Steel Pipe: Fabricated of ASTM A929/A929M galvanized steel sheet:

B. Tapered Ends: Same material as pipe, machine cut, for joining to pipe end.

C. Coupling Bands: Galvanized steel, 0.052 inches thick x 10 inches wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

2.03 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 312316.13.

B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.01 EXCAVATING

A. Excavate culvert trench to 12 inches below pipe invert. Hand trim excavation for accurate placement of pipe to elevations indicated.

3.02 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe and accessories in accordance with manufacturer's instructions

C. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

D. Shore pipe to required position; retain in place until after compaction of adjacent fills. Ensure pipe remains in correct position and to required slope.

E. Repair surface damage to pipe protective coating with two coats of compatible bituminous paint coating.

3.03 PIPE ENDS

END OF SECTION 334213

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 REFERENCE STANDARDS

A. AASHTO HB - Standard Specifications for Highway Bridges; 2005, with Errata.

B. ASTM C478/C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections; 2022.

C. ASTM C923/C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2020.

D. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants; 2009 (Reapproved 2019).

1.03 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.

1.04 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.

C. Trench Drain Grates: As indicated on drawing or grates conforming to AASHTO HS20.

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. Mount frame on prefabricated drop inlets or trench drains according to manufacturer's instructions.
   4. 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 334230

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SECTION 334600
STORMWATER MANAGEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stormwater ponds.

B. Outlet structures for stormwater ponds.

C. Modular buried stormwater storage units.

1.02 RELATED REQUIREMENTS

A. Section 033000 - CAST-IN-PLACE CONCRETE.

B. Section 310519 - Geosynthetics for Earthwork.

C. Section 312316 - Excavation.

D. Section 312316.13 - Trenching.

E. Section 312323 - Fill.

F. Section 330561 - Concrete Manholes.

G. Section 334211 - Stormwater Gravity Piping.

H. Section 334230 - Stormwater Drains.

1.03 PRICE AND PAYMENT PROCEDURES

A. Allowances:

1. See Section 012100 - DO NOT USE BSD Allowances for allowances affecting this section.

1.04 REFERENCE STANDARDS

A. AASHTO HB - Standard Specifications for Highway Bridges; 2005, with Errata.

B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

C. ASTM A929/A929M - Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe; 2024.

D. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures; 2021.

E. ASTM C923/C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2020.

F. ASTM D3282 - Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes; 2024.

G. ASTM D4873/D4873M - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples; 2017 (Reapproved 2021).

H. ASTM D6637/D6637M - Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method; 2015 (Reapproved 2023).

I. GRI GM13 - Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes; 2021.

1.05 ADMINISTRATIVE REQUIREMENTS

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

1.06 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.

C. Shop Drawings: Indicate stack assembly, invert elevations, opening sizes, and pipe angles.

D. Certificate: Certify that products of this section meet or exceed specified requirements.

E. Test Reports: Indicate optimum moisture content of fill materials.

F. Manufacturer's Instructions: Indicate seaming method.

G. Manufacturer's qualification statement.

H. Installer's qualification statement.

I. Testing agency's qualification statement.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three 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 and approved by manufacturer.

C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.

D. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions and shop drawings.

1.08 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for packaging waste requirements.

B. Identify, store, and handle geosynthetic rolls in accordance with 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.

PART 2 PRODUCTS

2.01 STORMWATER PONDS

A. Fill: See Section 312323.

B. Impermeable Layer: Group A-4 in accordance with ASTM D3282.

C. Geogrid: Geogrid for stabilization as specified in Section 310519.

2.02 OUTLET STRUCTURES FOR STORMWATER PONDS

A. Precast Concrete: Reinforced, integrated lift rings, in accordance with ASTM C913.
   1. Concrete: 4,000 psi minimum 28 day compressive strength.
   2. Wall Thickness: 4 inches (102 mm).
   3. Resilient Connectors: Natural rubber, in accordance with ASTM C923/C923M.

B. Corrugated Metal: Galvanized sheet steel in accordance with ASTM A929/A929M with helical lock seams.
   1. Coated inside and outside with 1/20 inch thick bituminous coating.

C. Trash Racks: Cast iron, heavy duty bar screen.
   1. Coated with 1/20 inch thick bituminous coating.

D. Concrete Base: See Section 033000.

2.03 MODULAR BURIED STORMWATER STORAGE UNITS

A. Modular Plastic: Open cell, interlocking, 100 percent recycled.

1. Loading: H-20 minimum, in accordance with AASHTO HB.
2. Manufacturers:
   a. Invisible Structures, Inc; _____: www.invisiblestructures.com/#sle.
   b. _____.
   c. _____.
   d. Substitutions: See Section 016000 - Product Requirements.

B. Geogrid: 1,300 lb/ft (19.0 kN/m) minimum ultimate tensile strength, when tested in accordance with ASTM D6637/D6637M.

C. Geomembrane: HDPE, comply with GRI GM13.
   1. Thickness: 60 mils, 3/50 inch.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Verify excavations are at correct topographies and areas to be filled are not compromised with surface or ground water.
   2. Verify items provided by other sections of work are properly sized and located.

3.02 PREPARATION

A. Coordinate placement of inlet and outlet pipe required by other sections.

3.03 POND CONSTRUCTION

A. Install geogrid according to manufacturer's instructions.

B. Install geogrid for stabilization as specified in Section 310519.

C. Fill to contours and elevations indicated using unfrozen materials.

D. Employ a placement method that does not disturb or damage other work.

E. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.

F. Maintain optimum moisture content of fill materials to attain required compaction density.

G. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

H. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.

3.04 POND OUTLET CONSTRUCTION

A. Form concrete base pad according to drawings, trowel top surface level.

B. Precast Structure: Place structure sections plumb and level, trim to correct elevations.
   1. Anchor to base pad.
   2. Cut and fit for pipe.
   3. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.

C. Corrugated Structure: Install elbow fitting and sections plumb and level, trim to correct elevations.
   1. Anchor to base pad.
   2. Cut and fit for pipe.

D. Set trash racks level without tipping, to correct elevations.

3.05 MODULAR UNIT INSTALLATION

A. Install modular units according to manufacturer's instructions.

B. Lay geogrid sheets on base in the direction of construction.

C. Lay geomembrane sheets on geogrid in the direction of construction.

D. Install modular units according to drawings, interlocking wherever possible.

E. Lay geogrid sheets on modular units in the direction of construction.

F. Cover top and sides of modular units with geomembrane, weld seams according to manufacturer's instructions.

G. Backfill without damaging modular units, geomembrane, or geogrid as specified in Section 312323.

3.06 LEACHING PIT INSTALLATION

A. Precast Concrete: Place structure sections plumb and level, trim to correct elevations.
   1. Cut and fit for pipe.

B. Concrete Masonry Unit: Place masonry units plumb and level in running bond with open joints.
   1. Place according to drawings.

C. Set cover level without tipping, to correct elevations.

D. Install frames and grate to correct position and elevation.

E. Backfill 12 inches (305 mm), minimum, around pit with stone as specified in Section 312323.

END OF SECTION 334600

SECTION 335216
GAS HYDROCARBON PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Valves.

B. Related Requirements:
   1. Section 221114 - Facility Natural-Gas Piping: Requirements for gas piping within Building Footprint.
   2. Division 31 - Earthwork: Requirements for excavation, backfill, and trenching as required by this Section.

1.02 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

D. ASME B31.8 - Gas Transmission and Distribution Piping Systems; 2025.

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

F. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

G. 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 (Reapproved 2021).

H. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2026.

I. ASTM D2517 - Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings; 2018 (Reapproved 2023).

J. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

K. NFPA 54 - National Fuel Gas Code; 2024.

1.03 PREINSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this Section.

1.04 SUBMITTALS

A. Manufacturer’s installation instructions shall be provided along with product data.

B. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

C. Product Data: Submit manufacturer information regarding pipe materials, pipe fittings, valves, and accessories.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Qualifications Statement:
   1. Submit qualifications for manufacturer.
   2. Submit qualifications for Contractor performing all exterior piping
      a. **Contractor shall be a Certified Contractor meeting all of Con Edison's requirements/certifications.**

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents:
   1. Record actual locations of piping mains, valves, and connections.
   2. Record actual invert elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALITY ASSURANCE

A. Welding Materials and Procedures: Comply with AWS D1.1/D1.1M.

B. Comply with NFPA 54.

C. Perform Work according to local gas company requirements and all applicibale Federal, State, and local codes.

D. Furnish valves with manufacturer's name and pressure rating marked on valve body.

E. Maintain one (1) copy of each standard affecting Work of this Section on Site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing piping system products specified in this Section with minimum three (3) years documented experience.

B. Welders: AWS qualified within previous 12 months for employed weld types.

C. Installer: Company specializing in the installation of natural gas piping, in both low pressure and high pressure scenarios, meeting all the requirements set forth from the local gas utility (Con Edison).

1.08 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Handling: Support each assembly with nylon slings.

C. Storage:
   1. Store materials according to manufacturer instructions.
   2. Provide wooden shipping braces between layers of stacked pipe.
   3. Stack piping lengths no more than three layers high.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide temporary end caps and closures on piping and fittings, and maintain in place until installation.
   3. Protect piping system pieces from entry of foreign materials and water by temporary covers, by completing sections of Work, and by isolating parts of completed system.
   4. Cover piping system during storage with light-colored or opaque tarpaulin to prevent jacket discoloration that may be caused by UV rays.
   5. Provide additional protection according to manufacturer instructions.

1.09 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Furnish one (1)-year manufacturer's warranty for valves and regulators.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING

A. Pipe and Fittings:
1. Piping: As specified in Section 221114 - Facility Natural-Gas Piping.
2. Steel Piping , Belowground:
a. Pipe:
1) Type: Black; welding.
2) Comply with ASTM A53, Grade B ???_____???.
3) Schedule: 40.
b. Fittings:
1) Material: Forged steel.
2) Comply with ASME B16.11[ASTM A234.
c. Joints: Welded.
d. Jackets: PE; AWWA C105.
3. Steel Piping , Aboveground:
a. Pipe:
1) Type: Black; welding.
2) Comply with ASTM A53, Grade B ???_____???.
3) Schedule: 40.
b. Fittings: Malleable iron; ASME B16.3.
c. Joints: Threaded.
4. Copper Tubing , Belowground:
a. Tube:
1) Comply with ASTM B88.
2) Type K.
3) Internally tinned.
b. Fittings:
1) Cast copper; ASME B16.18.
2) Internally tinned.
c. Joints:
1) Comply with AWS A5.8.
2) Classification: BCuP silver brazed.
5. PE Piping (HDPE):
a. Pipe: Comply with ASTM D2513 , SDR 11.5 .
b. Fittings: Comply with ASTM D2513 .
c. Joints: Fusion welded .
6. Reinforced Epoxy Resin Piping:
a. Pipe: Comply with ASTM D2517.
b. Fittings: Comply with ASTM D2517.
c. Joints: Bell and spigot with epoxy resin.

2.02 VALVES

A. Plug Valves:
1. Manufacturers:
a. Fisher Control Valves & Instruments.
b. Sensus.
c. Approved equivalent.
2. 2 Inches and Smaller:
a. Comply with ASME B16.33.
b. Pressure Rating:150-psig WOG.
c. Body: Bronze.

d. Plug: Bronze, tapered.
e. Lubricated.
f. Packing: PTFE.
g. End Connections: Threaded.
h. Furnish cast-iron curb box, cover, and key.

3. 2-1/2 Inches and Larger:
a. Comply with ASME B16.33.
b. Pressure Rating: 125-psig WOG.
c. Body: Steel.
d. Plug: Tapered.
e. Lubricated.
f. Packing: PTFE.
g. End Connections: Threaded.
h. Furnish cast-iron curb box, cover, and key.

B. Pressure-Regulating Valves:
1. Manufacturers:
a. Fisher Control Valves & Instruments.
b. Pietro Fiorentini.
c. Baker Hughes Valves (Mooney).
d. Approved equivalent.
2. Description:
a. Corrosion-resistant pressure regulator with atmospheric vent and elevation compensator.
b. Type: Single stage.
c. Body: Malleable iron.
d. End Connections:
1) Valves 2 Inches and Smaller: Threaded.
2) Valves 2-1/2 Inches and Larger: Flanged.
3. Capacity: Inlet and outlet gas pressures, specific gravity, and flow rate as indicated on Drawings.

2.03 MATERIALS

A. All pipe bedding & backfill material to be described on the contract drawings and within Section 312323 - Fill.

2.04 ACCESSORIES

A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Gas Service" in large letters.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that connection to existing piping system, sizes, locations, and inverts are as indicated on Drawings.

3.02 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

B. Bevel plain end ferrous pipe, 2-1/2 inches in diameter and larger.

C. Remove scale and dirt on inside and outside of piping before assembly.

D. Prepare piping connections with flanges unions.

E. Correct over-excavation with fine aggregate.

F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

3.03 INSTALLATION

A. Excavation, Trenching, and Bedding:
   1. Excavate pipe trench as specified in Section 312316.13 - Trenching .
   2. Excavate for manholes as specified in Section 312316.13 - Trenching & 312316 - Excavation.
   3. Place bedding material at trench bottom.
   4. Level fill materials in continuous layers not exceeding 6 inches in depth, and compact to 95 percent maximum density (modified proctor).
   5. Backfill around sides and to top of pipe with cover fill, tamp in place, and compact to 95 percent maximum density (modified proctor).
   6. Maintain optimum moisture content of bedding material to attain required compaction density.

B. Piping:
   1. Maintain separation of gas line from sewer piping, as indicated on Drawings.
   2. Group piping with other Site piping Work whenever practical.
   3. Route piping in straight line.
   4. Install piping to conserve space and to not interfere with use of Site space.
   5. Install piping to allow for expansion and contraction without stressing pipe or joints, as approved by Director's Representative.
   6. Install valves and other fittings as indicated on Drawings.
   7. Establish elevations of buried piping to meet all Utility required depths as well as cover requirements indicated on the Drawings.
   8. Wrap couplings and fittings of steel pipe with PE tape and heat-shrink over pipe.

C. Backfilling and Compacting:
   1. As specified in Division 31 - Earthwork.
   2. Do not displace or damage pipe while compacting.

D. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Gas Service" in large letters.

E. Valve Boxes:
   1. Center and plumb valve boxes over valves.
   2. Set box cover flush with finished ground surface.
   3. Prevent shock or stress from being transmitted through valve box to valve.
   4. Wrap valve and valve box with PE tape and heat shrink.

F. Service Connections:
   1. Install sleeve in foundation wall for gas service main, and seal enlarged sleeve watertight.
   2. Anchor service main to interior surface of foundation wall.
   3. Install service regulator adjacent to building wall as indicated on Drawings.
   4. Install pressure-regulating valve and riser pipe as to prevent undue stress upon service pipe.
   5. For plastic service pipe, use steel pipe riser from below ground to regulator.
   6. Install regulator vent with rain- and insect-proof opening, terminating away from building openings.
   7. Install medium-pressure gas-pressure regulator with tee fitting between regulator and upstream shutoff valve, and cap or plug one opening of tee fitting.
   8. Install medium-pressure gas-pressure regulator with tee fitting not less than 10 pipe diameters downstream of regulator, and cap or plug one opening of tee fitting.

9. Install gas service to within 5 feet of building, and connect to building gas service as specified in Section 221114 - Facility Natural-Gas Piping.
10. Coordinate with Utility & Owner to Locate gas meter and pressure-reducing valve at building.

3.04 FIELD QUALITY CONTROL

A. See Section 014000-Quality Requirements, for additional requirements.

B. Testing:
   1. Pressure Test:
      a. Installed High Pressure Gas Piping: To **200 psig**
      b. Installed Low/Medium Pressure Gas Piping: To **150 psig**.
      c. Comply with NFPA 54.
      d. Inspect, test, and purge gas piping according to Uniform Code and local gas company requirements.
   2. Compaction Testing:
      a. Comply with ASTM D1557.

C. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests at not additional cost to the Owner.

3.05 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 335216

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 340551

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