

PROJECT MANUAL

VOLUME TWO

SOUTH ORANGETOWN CENTRAL SCHOOL DISTRICT

2022 BOND PROJECT - PHASE 1

160 Van Wyck Road

Blauvelt, New York - 10913

DIVISIONS 22 THROUGH 33

CPL PROJECT NO.: 14457.20

DOCUMENT ISSUE DATE: OCTOBER 18, 2023

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

William O. Schaefer Elementary: SED#50-03-01-06-0-012-019

Cottage Lane Elementary: SED#50-03-01-06-0-010-022

Tappan Zee High School: SED#50-03-01-06-0-006-032

William O. Schaefer Sound & Lockdown: SED#50-03-01-06-0-012-020

Cottage Lane Sound & Lockdown: SED#50-03-01-06-0-010-023

Cottage Lane Library Sound & Lockdown: SED#50-03-01-06-8-023-002

WOS Outdoor Classroom: SED#50-03-01-06-7-053-001

CLE Outdoor Classroom: SED#50-03-01-06-7-054-001

SOMS Outdoor Classroom: SED#50-03-01-06-7-056-001

TZHS Outdoor Classroom: SED#50-03-01-06-7-055-001

Registration Expiration Dates:

Lauren Tarsio	09/30/26	Anthony Marchetti	05/31/24
Richard Waite	11/30/23	Dave Hart	02/28/25
Larry Werts	12/31/24	Jennifer Wengender	06/30/24

Certificate # 018330

DESIGN PROFESSIONAL'S CERTIFICATION:

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

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SECTION 220500**COMMON WORK RESULTS FOR PLUMBING****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. This Section includes the following:
1. 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.
 8. Painting and finishing.
 9. Supports and anchorages.

1.3 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. 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.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 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.

1.6 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.

1.7 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."

PART 1 PRODUCTS

2.1 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.

2.2 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.

2.3 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.

2.4 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.

2.5 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.

2.6 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.

2.7 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.

2.8 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

3.1 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.
- 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.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 GROUTING

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

END OF SECTION

SECTION 220517**SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SECTION INCLUDES

- A. Pipe sleeves.
- B. Stack-Sleeve fittings.
- C. Sleeve-Seal Fittings
- D. Grout

1.3 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.

1.4 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2023a.

1.5 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.

1.6 QUALITY ASSURANCE

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

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- 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.

1.7 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.

1.8 WARRANTY

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

PART 2 PRODUCTS**2.1 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.
- F. Clearances:
1. Provide allowance for insulated piping.
 2. Wall, Floor, Partitions, and Beam Flanges: 1 inch (25 mm) 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.

2.2 STACK-SLEEVE FITTINGS

- A. Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping rings with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

2.4 GROUT

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

PART 3 EXECUTION

3.1 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.

3.2 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. 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.

3.3 CLEANING

- A. Upon completion of work, clean all parts of the installation.

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- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.
- C. See Section 017419 - Construction Waste Management and Disposal for additional requirements.

END OF SECTION

SECTION 220523**GENERAL-DUTY VALVES FOR PLUMBING PIPING****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SECTION INCLUDES

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

1.3 RELATED REQUIREMENTS

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

1.4 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.

1.5 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).
- B. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves 2022.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- D. ASME B31.9 - Building Services Piping 2020.
- E. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings 2015 (Reapproved 2021).
- F. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- G. AWWA C606 - Grooved and Shouldered Joints 2022.
- H. MSS SP-67 - Butterfly Valves 2022.
- I. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
- J. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.

- K. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
- L. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- M. NSF 372 - Drinking Water System Components - Lead Content 2022.

1.6 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.

1.7 QUALITY ASSURANCE

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

1.8 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.

1.9 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**2.1 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.

2.2 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 (50 mm, DN) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. 2-1/2 inch (65 mm, DN) 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 (50 mm, DN) and Smaller: Threaded ends.
 - b. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
 2. Copper Tube:
 - a. 2 inch (50 mm, DN) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

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- b. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
- E. Low Pressure, Compressed Air Valves 150 psi (1,035 kPa) or Less:
 - 1. 2 inch (50 mm, DN) and Smaller:
 - a. Bronze: Provide with solder-joint ends.
 - 2. 2-1/2 inch (65 mm, DN) and Larger:
 - a. Iron, 2-1/2 NPS (65 DN) to 4 NPS (100 DN): Provide with flanged or Welded ends.
- F. Domestic, Hot and Cold Water Valves:
 - 1. 2 inch (50 mm, DN) 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 (65 mm, DN) and Larger:
 - a. Iron Grooved-End Butterfly: 175 CWP.
 - b. Iron Swing Check: Class 125, metal seats.

2.3 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 (50 mm, DN) 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.

2.4 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 (1,035 kPa).
3. WOG Rating: 600 psi (4,140 kPa).
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
 - d. Viega LLC: www.viega.us/#sle.

2.5 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 (1,380 kPa).
3. Design: Vertical flow.
4. Body: Comply with ASTM B61 or ASTM B62, bronze.
5. End Connections: Threaded.
6. Disc (Type 1): Bronze.

2.6 BRASS, HORIZONTAL SWING CHECK VALVES**A. Class 125, Threaded or Soldered End Connections:**

1. WOG Rating: 200 psi (1,380 kPa).
2. Body: Forged brass.
3. Disc: Forged brass.
4. Hinge-Pin, Screw, and Cap: Forged brass.

2.7 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 (1,380 kPa).
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded.
6. Disc: Bronze.

PART 3 EXECUTION**3.1 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.

3.2 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

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SECTION 220529**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other plumbing work.

1.3 RELATED REQUIREMENTS

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

1.4 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- E. MFMA-4 - Metal Framing Standards Publication 2004.
- F. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).
- G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.5 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.

1.6 DEFINITIONS

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

1.7 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.

1.8 SUBMITTALS

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

1.9 QUALITY ASSURANCE

- A. Comply with applicable building code.

PART 2 PRODUCTS**2.1 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 _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Metal Channel (Strut) Framing Systems:

1. Comply with MFMA-4.

C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.**D. Thermal Insulated Pipe Supports:**

1. General Construction and Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch (12.7 mm to 762 mm) iron pipes.
 - d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by a 360 degree, PVC jacketing.
2. PVC Jacket:

E. Pipe Supports:

1. Liquid Temperatures Up To 122 degrees F (50 degrees C):
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.

- b. Support From Below: MSS SP-58 Types 35 through 38.

F. Anchors and Fasteners:

- 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.

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- 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

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SECTION 220553**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SECTION INCLUDES

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

1.3 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Identification painting.

1.4 REFERENCE STANDARDS

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

1.5 SUBMITTALS

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

PART 2 PRODUCTS**2.1 IDENTIFICATION APPLICATIONS**

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

2.2 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
- B. Description: Laminated three-layer plastic with engraved letters.

1. Letter Color: White.
2. Letter Height: 1/4 inch (6 mm).
3. Background Color: Black.
4. Plastic: Comply with ASTM D709.

2.3 TAGS

A. Manufacturers:

1. Brimar Industries, Inc: www.pipemarker.com/#sle.
2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
3. Seton Identification Products: www.seton.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 STENCILS

A. Manufacturers:

1. Brady Corporation: www.bradycorp.com/#sle.
2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com/#sle.
3. Seton Identification Products: www.seton.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Stencils: With clean cut symbols and letters of following size:

1. 1-1/2 to 2 inch (40-50 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 3/4 inch (20 mm) high letters.

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

2.5 PIPE MARKERS

A. Manufacturers:

1. Brimar Industries, Inc: www.pipemarker.com/#sle.
2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
3. Seton Identification Products: www.seton.com/#sle.

B. Comply with ASME A13.1.

- C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Color code as follows:
 - 1. Domestic Water, Storm Drainage, Waste & Vent: Green with white letters.

PART 3 EXECUTION**3.1 PREPARATION**

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

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 099123.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
- G. Use tags on piping 3/4 inch (20 mm) diameter and smaller.
- H. Install labels and/or tags on all pipes as follows:
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet (6 m) 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

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SECTION 220719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

1.3 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 2019).
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.
- 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 2013 (Reapproved 2019).
- H. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing 2022.

- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2023).
- J. ASTM C1695 - Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service 2022.
- K. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics 2019.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- M. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 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.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

PART 2 PRODUCTS

2.1 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.

2.2 GLASS FIBER

2.3 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

- A. Insulation: ASTM C553 Type V; flexible, noncombustible.
 - 1. Comply with ASTM C1695.

2. K (Ksi) Value: 0.37 at 100 degrees F (0.053 at 38 degrees C), when tested in accordance with ASTM C177 or ASTM C518.
3. Minimum Service Temperature: 32 degrees F (0 degrees C).
4. Maximum Service Temperature: 500 degrees F (260 degrees C).
5. Maximum Water Vapor Absorption: Less than 5.0 percent by weight.
6. Color: Green.
7. Weight: 7.65 oz per sq ft (2334.4 g per sq m).
8. Effective Thickness: 1.25 plus/minus 0.25 inch (0.032 plus/minus 0.0064 m).

2.4 CELLULAR GLASS

A. Insulation: ASTM C552, Type II, Grade 6.

1. K (Ksi) Value: 0.35 (0.050) at 100 degrees F (38 degrees C).
2. Service Temperature Range: From 250 degrees F (121 degrees C) to 800 degrees F (427 degrees C).
3. Water Vapor Permeability: 0.005 perm inch (0.007 ng/Pa s m) maximum per inch.
4. Water Absorption: 0.5 percent by volume, maximum.

2.5 JACKETS

A. PVC Plastic.

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F (Minus 18 degrees C).
 - b. Maximum Service Temperature: 150 degrees F (66 degrees C).
 - c. Moisture Vapor Permeability: 0.002 perm inch (0.0029 ng/Pa s m), maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil (0.25 mm).
 - e. Connections: Brush on welding adhesive.

B. ABS Plastic:

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
 - b. Maximum Service Temperature: 180 degrees F (82 degrees C).
 - c. Moisture Vapor Permeability: 0.012 perm inch (0.018 ng/Pa s m), when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 30 mil (0.76 mm).
 - e. Connections: Brush on welding adhesive.

- C. Canvas Jacket: UL listed 6 oz/sq yd (220 g/sq m) plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 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.
- 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 (60 degrees C) 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 (40 mm) diameter or larger.

3.3 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: 1-1/2 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

D. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.

3.4 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

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SECTION 221005
PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sanitary waste piping, buried within 5 feet (1500 mm) of building.
- B. Domestic water piping, buried within 5 feet (1500 mm) of building.
- C. Domestic water piping, above grade.

1.2 RELATED REQUIREMENTS

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

1.3 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. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV 2021.
- D. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV 2022.
- E. ASME B31.9 - Building Services Piping 2020.
- F. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings 2021.
- G. ASTM B32 - Standard Specification for Solder Metal 2020.
- H. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.
- I. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
- J. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV) 2020.
- K. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube 2016.
- L. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings 2016.
- M. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.

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

1.4 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.

1.5 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.

1.6 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.

1.7 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

- B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.2 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

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

2.3 SANITARY SEWER AND SANITARY VENT PIPING, ABOVE GRADE

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

2.4 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

- A. Ductile Iron Pipe: AWWA C151/A21.51.
1. Fittings: Ductile or gray iron, standard thickness.
 2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch (19 mm) diameter rods.

2.5 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.

2.6 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.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 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.

3.3 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 (____ m) of cover for pipes that require freeze protection.
- I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; see Section ____.
- J. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
 - 1. See Section 099113 for painting of exterior plumbing systems and components.
- K. Excavate in accordance with Section 312316.
- L. Backfill in accordance with Section 312323.
- M. Install valves with stems upright or horizontal, not inverted. See Section 220523.
- N. Install water piping to ASME B31.9.
- O. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- P. Sleeve pipes passing through partitions, walls, and floors.
- Q. Pipe Hangers and Supports:
 - 1. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- R. 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.

3.4 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.

3.5 FIELD TESTS AND INSPECTIONS

- A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.
- B. Domestic Water Systems:
 1. Perform hydrostatic testing for leakage prior to system disinfection.
 2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
 3. General:
 - a. Fill the system with water and raise static head to 10 psi (345 kPa) above service pressure. Minimum static head of 50 to 150 psi (345 to 1,034 kPa). As an exception, certain codes allow a maximum static pressure of 80 psi (551.6 kPa).
- C. Gas Distribution Systems:
 1. Test Preparation: Close each appliance valve or disconnect and cap each connected appliance.
 2. General Systems:
 - a. Inject a minimum of 10 psi (68.9 kPa) 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 (0.45 kg).
 3. Welded Pipes or Systems with Service Pressures Above 14 in-wc (3.48 kPa):

- a. Inject a minimum of 60 psi (413.7 kPa) 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 (0.45 kg) with 1 psi (6.9 kPa) increments.
- D. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.6 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.

3.7 SERVICE CONNECTIONS

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

END OF SECTION

SECTION 221006
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Cleanouts.
- B. Floor Drains
- C. Water hammer arrestors.
- D. Escutcheons
- E. Floor Plates

1.3 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Manhole bottoms.
- B. Section 221005 - Plumbing Piping.
- C. Section 223000 - Plumbing Equipment.
- D. Section 224000 - Plumbing Fixtures.

1.4 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ASME A112.6.3 - Floor and Trench Drains 2019.
- C. ASME A112.6.4 - Roof, Deck, and Balcony Drains 2022.
- D. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers 2023.
- E. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies 2021.
- F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance 2011 (Reaffirmed 2016).
- G. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- H. NSF 372 - Drinking Water System Components - Lead Content 2022.
- I. PDI-WH 201 - Water Hammer Arresters 2017.

1.5 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.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

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

2.2 ESCUTCHEONS

- A. One-piece, Cast-brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-piece, Deep-Pattern Type: Deep-drawn, box-shaped with chrome-plated finish and spring-clip fasteners.
- C. One-piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with the concealed hinge and setscrew.

2.3 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Castbrass with concealed hinge.

2.4 FLOOR DRAINS (FD-1)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers product offering that may be incorporated into the work include, but are not limited to, the following:
 - 1. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
 - 2. MIFAB, Inc: www.mifab.com/#sle.
 - 3. Watts Equal to **FD-100-A**
 - 4. Substitutions: See Section 016000 - Product Requirements.

- B. 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.

2.5 CLEANOUTS (FCO & WCO)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers product offering that maybe incorporated into the work include, but are not limited to, the following:
- B. Cleanouts at Interior Finished Floor Areas (**FCO**):
 - 1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished 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.

2.6 WATER HAMMER ARRESTORS (HA-1)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers product offering that maybe incorporated into the work include, but are not limited to, the following:
 - 1. Jay R. Smith Manufacturing Company: www.jayrsmith.com/#sle.
 - 2. Watts Regulator Company, a part of Watts Water Technologies:
www.wattsregulator.com/#sle. **Equal to LF15M2-DR**
 - 3. Zurn Industries, LLC: www.zurn.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Water Hammer Arrestors:
 - 1. Stainless steel construction, piston type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F (minus 73 to 149 degrees C) and maximum 250 psi (1700 kPa) working pressure.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install escutcheons for piping penetration of walls, ceilings, and finished floors.
- C. Install escutcheons with ID to closely fit around the pipe, tube, and insulation and with OD that completely covers the opening.

1. Escutcheons for New Piping:
 - a. Piping with Fittings or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plating Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type.
 - 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 Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
2. Escutheons for Existing Pipe:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - c. Bare Piping at Wall or Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished chrome-plate finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
- D. Install floor plates for piping penetrations of equipment-room floors.
- E. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping with OD that completely covers opening.
 1. New Piping: One-piece, floor plate type.
 2. Existing Piping: Split-casting, floor-plate type.
- F. 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.
- G. Encase exterior cleanouts in concrete flush with grade.
- H. Install floor cleanouts at elevation to accommodate finished floor.

- I. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks or Sinks.

END OF SECTION

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SECTION 224000
PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water closets.
- B. Lavatories.
- C. Sinks.
- D. Under-lavatory pipe supply covers.

1.2 RELATED REQUIREMENTS

- A. Section 064100 - Architectural Wood Casework: Preparation of 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.

1.3 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use 1997 (Reaffirmed 2017).
- C. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
- D. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures 2011 (Reaffirmed 2022).
- E. ASME A112.19.1 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures 2018.
- F. ASME A112.19.2 - Ceramic Plumbing Fixtures 2018, with Errata.
- G. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures 1994 (Reaffirmed 2009).
- H. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks 2022.
- I. ASME A112.19.15 - Bathtubs/Whirlpool Bathtubs with Pressure Sealed Doors 2012 (Reaffirmed 2022).
- J. ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers 2020.
- K. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices 2020.
- L. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping 2021.

- M. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- N. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- O. NSF 372 - Drinking Water System Components - Lead Content 2022.
- P. UL (DIR) - Online Certifications Directory Current Edition.

1.4 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.

1.5 QUALITY ASSURANCE

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

1.6 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.

1.7 WARRANTY

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

PART 2 PRODUCTS

2.1 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.

2.2 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.

2.3 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. Substitutions: See Section 016000 - Product Requirements.

2.4 FLUSH VALVE WATER CLOSETS AD(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 (1117 mm) or less.
 - 5. Outlet Size: 4 inches (101 mm).
 - 6. Color: White.
- B. 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.
- C. See Plumbing Schedule for Model Information
- D. Seats:
 - 1. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.
- E. See Plumbing Schedule for Model Information

F. 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.

2.5 FLUSH VALVE WATER CLOSETS - CHILD HEIGHT (WC-2)

A. Water Closets: Vitreous china, ASME A112.19.2, floor mounted, 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 (1117 mm) or less.
5. Supply Size: 1-1/2 inches (38 mm).
6. Outlet Size: 4 inches (101 mm).
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

2.6 LAVATORIES - ADA (LAV-1)

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 (9 mm) compression connections.
- G. Aerator: Vandal resistant, 0.5 GPM (1.89 LPM), laminar flow device.
- H. Sensor range: Factory set at a minimum of 3 inch (76 mm) adjustable up to 24 inch (610 mm).
- I. Finish: Polished chrome.
- J. Accessory: 4 inch (102 mm) 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 (1.37 mm) 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.

2.7

2.8 SINKS (SK-1)

- A. Sink Manufacturers:
 1. American Standard, Inc: www.americanstandard-us.com/#sle.
 2. Kohler Company: www.kohler.com/#sle.
 3. Meganite, Inc: www.meganite.com/#sle.
 4. Relang International, LLC; DURASEIN: www.duraseinusa.com/#sle.
- B. See Plumbing Schedule for Model Information
- C. Faucet: ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with maximum flow of 2.2 gallons per minute (8.3 liters per minute), indexed handles.
- D. Manufacturers:
 1. Jay R. Smith MFG. Co: www.jrsmith.com/#sle.

2.9 UNDER-LAVATORY PIPE SUPPLY COVERS

A. Manufacturers:

1. Plumberex Specialty Products, Inc: www.plumberex.com/#sle.
2. 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 (3.2 mm) 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.

PART 3 EXECUTION

3.1 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.

3.2 PREPARATION

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

3.3 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 hold fixture in place.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

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

3.5 ADJUSTING

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

3.6 CLEANING

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

3.7 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

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SECTION 230000
GENERAL PROVISIONS FOR MECHANICAL WORK

PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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.

1.7 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.

1.8 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 costs 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.

1.9 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 warranties may be indicated in other sections. In all cases, the more stringent guarantee or warranty shall be provided.

PART 2 - PRODUCTS**2.1 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.

2.2 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**3.1 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.

3.2 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

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SECTION 230002
MECHANICAL AND ELECTRICAL COORDINATION**PART 1 - GENERAL****1.1 WORK INCLUDED**

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

1.2 RELATED WORK SPECIFIED ELSEWHERE

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

1.3 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.

1.4 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.

1.5 DIVISION OF WORK

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

1.6 WORK REQUIRED UNDER DIVISION 23

- A. Furnish motors, manual and combination starters, pushbutton devices, contactors, disconnect switches, electric thermostats, low voltage transformers, Emergency Break Glass Stations and other electrical devices required for equipment furnished.
- B. Install all items in piping and ductwork such as control valves, aquastats, ductstats, etc.
- C. All external wiring of equipment, all temperature control wiring, external wiring of control circuits of magnetic starters, interlocking wiring, boiler wiring, Emergency Break Glass Stations, and mounting of control devices, etc., shall be included under Division 23. All external wiring shall be in conduit. (Unless specifically shown to be provided by the Electrical Contractor)

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

1.7 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

2.1 ACCEPTABLE MANUFACTURERS

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

2.2 MOTOR CONTROLLERS

- A. General: All starters shall be correctly sized to motor connected thereto. Provide one (1) additional auxiliary contact over and above that normally furnished, at least two (2) required. Provide overload heaters for each phase. Coordinate starters and controllers with the temperature control Contractor and sequence of operations.
- B. Minimum Size: The minimum allowable size of single or three phase magnetic motor controller is NEMA size 0.
- C. Enclosures: Unless otherwise indicated furnish NEMA 1 enclosures, except where installed outdoors furnish NEMA 3R enclosures.
- D. Control Power: Furnish control power transformer (maximum control voltage 120 volts) mounted within each magnetic motor controller enclosure.

- E. Pilot Lights: Furnish pilot lights of the neon lamp type mounted in the controller enclosure, green for running, red for not running.

2.3 MOTOR CONTROLLER TYPES:

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

2.4 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.

2.5 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.

2.6 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.

2.7 CUSTOM LEGEND PLATE

- A. "EMERGENCY BOILER SHUTOFF"

PART 3 - EXECUTION**3.1 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.

3.2 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.

- C. Emergency Pushbutton Operator Station: Wire all switches in series with boiler control branch circuits.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 DISCONNECTS

- A. Motor Controllers: Provide safety switch for all motor controllers. Provide combination type starter-disconnect unless otherwise noted on drawings.
- B. Motors: Provide a disconnect switch for all motors. Provide a separate safety switch for motors which are not within sight of the starter.
- C. Provide safety switches for all factory packaged equipment.
- D. Provide NEMA 3R safety switch for all rooftop and outdoor equipment.
- E. Provide unit mounted disconnect switches for all equipment such as unit heaters, fans, unit ventilators, incremental units, etc

END OF SECTION

SECTION 230513**COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT-CPL****PART 1 GENERAL****1.1 SECTION INCLUDES**

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

1.2 RELATED REQUIREMENTS

- A. Section 262913 - Enclosed Controllers.

1.3 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators 2017.
- C. NEMA MG 1 - Motors and Generators 2021.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 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.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.6 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.

1.7 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**2.1 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.

2.2 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 (40 degrees C) environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- C. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.3 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.

2.4 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.

2.5 THREE PHASE POWER - SQUIRREL CAGE MOTORS

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

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

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

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

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

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

END OF SECTION

SECTION 230517**SLEEVES AND SLEEVE SEALS FOR HVAC PIPING-CPL****PART 1 GENERAL****1.1 SECTION INCLUDES**

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2023a.

1.4 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.

1.5 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.

1.6 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**2.1 PIPE SLEEVES**

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch (25 mm) above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch (40 mm) angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch (40 mm) angle ring or square set in silicone adhesive around penetration.
- B. Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Pipe Passing Through Mechanical Room Floors above Basement:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.

E. Clearances:

1. Provide allowance for insulated piping.
2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch (25 mm) 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.

2.2 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Modular/Mechanical Seal:

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

PART 3 EXECUTION**3.1 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.

3.2 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 (100 mm).
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- E. Structural Considerations:
 1. Do not penetrate building structural members unless indicated.
- F. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 1. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch (12.5 mm) where penetrations occur between conditioned and unconditioned spaces.
 2. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.
 3. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- G. Manufactured Sleeve-Seal Systems:
 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.

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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.

3.3 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

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**SECTION 230519
METERS AND GAUGES FOR HVAC PIPING-CPL****PART 1 GENERAL****1.1 SECTION INCLUDES**

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

1.2 REFERENCE STANDARDS

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

1.3 SUBMITTALS

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

1.4 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**2.1 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 (115 mm) diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.

2.2 PRESSURE GAUGE TAPPINGS

- A. Needle Valve: Brass, 1/4 inch (6 mm) NPT for minimum 150 psi (1034 kPa).
- B. Pulsation Damper: Pressure snubber, brass with 1/4 inch (6 mm) connections.
- C. Syphon: Steel, Schedule 40, 1/4 inch (6 mm) angle or straight pattern.

2.3 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 (225 mm) scale.
 2. Window: Clear Lexan.
 3. Stem: 3/4 inch (20 mm) NPT brass.
 4. Accuracy: 2 percent, per ASTM E77.
 5. Calibration: Degrees F.

2.4 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 (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 TEST PLUGS

- A. Test Plug: 1/4 inch (6 mm) or 1/2 inch (13 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F (93 degrees C).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.
- C. Install pressure gauges on the inlet and outlet piping of all hydronic zones, hydronic coils, and heat transfer equipment.
- D. Install pressure gauges upstream and downstream of all pressure reducing valves.
- E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- F. Install thermometers in air duct systems on flanges.
- G. Install thermometers in the return duct, outside air duct, inlet duct, and supply duct of all air handling systems and terminal units.
- H. Install thermometers on the inlet and outlet piping of all hydronic zones, hydronic coils, and heat transfer equipment.
- I. Locate duct mounted thermometers minimum 10 feet (3 m) downstream of mixing dampers, coils, or other devices causing air turbulence.
- J. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- K. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- L. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- M. Locate test plugs adjacent to pressure gauges and pressure gauge taps.

END OF SECTION

SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING-CPL**PART 1 GENERAL****1.1 SECTION INCLUDES**

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

1.2 RELATED REQUIREMENTS

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

1.3 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. SWP: Steam working pressure.
- I. TFE: Tetrafluoroethylene.
- J. WOG: Water, oil, and gas.

1.4 REFERENCE STANDARDS

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

- K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- L. AWWA C606 - Grooved and Shouldered Joints 2022.
- M. MSS SP-45 - Drain and Bypass Connections 2020.
- N. MSS SP-67 - Butterfly Valves 2022.
- O. MSS SP-68 - High Pressure Butterfly Valves with Offset Design 2021.
- P. MSS SP-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-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

1.5 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.

1.6 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.

1.7 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

2.1 APPLICATIONS

- A. Provide the following valves for the applications if not indicated on drawings:
 - 1. Throttling (Hydronic): Ball and Globe.
 - 2. Throttling (Steam): Gate.

3. Isolation (Shutoff): Gate and Ball.
- B. Required Valve End Connections for Non-Wafer Types:
 1. Steel Pipe:
 - a. 2 NPS (50 DN) and Smaller: Threaded ends.
 - b. 2-1/2 NPS (65 DN) and Larger: Grooved ends or flanged.
 2. Copper Tube:
 - a. 2 NPS (50 DN) and Smaller: Threaded ends (Exception: Solder-joint valve-ends).
- C. Heating Hot Water Valves:
 1. 2 NPS (50 DN) and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - b. Ball: Full port, two piece, stainless steel trim.
 - c. Swing Check: Bronze disc, Class 125.
 - d. Globe: Bronze disc, Class 125.
 2. 2-1/2 NPS (65 DN) and Larger, Iron Valves:
 - a. Single-Flange Butterfly: 2-1/2 NPS (65 DN) to 12 NPS (300 DN), aluminum-bronze disc, EPDM seat, 200 CWP.
 - b. Grooved-End Butterfly: 2-1/2 NPS (65 DN) to 12 NPS (300 DN), 175 CWP.
 - c. Swing Check: Metal seats, Class 125.
 - d. Grooved-End Swing Check: 3 NPS (80 DN) to 12 NPS (300 DN), 300 CWP.

2.2 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 1. Gear Actuator: Quarter-turn valves 8 NPS (200 DN) and larger.
 2. Handwheel: Valves other than quarter-turn types.
 3. Hand Lever: Quarter-turn valves 6 NPS (150 DN) and smaller.
- D. Valves in Insulated Piping: Provide 2 NPS (50 DN) stem extensions and the following features:
 1. Gate Valves: Rising stem.
 2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 3. Butterfly Valves: Extended neck.
 4. Memory Stops: Fully adjustable after insulation is installed.
- E. Memory Stops: Fully adjustable after insulation is installed.
- F. Valve-End Connections:
 1. Threaded End Valves: ASME B1.20.1.
 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 3. Pipe Flanges and Flanged Fittings 1/2 NPS (15 DN) through 24 NPS (600 DN): 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.

2.3 BRONZE, GLOBE VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa).
 - 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.

2.4 BRONZE, BALL VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Two Piece, Full Port with Stainless Steel Trim:
 - 1. Comply with MSS SP-110.
 - 2. SWP Rating: 150 psig (1035 kPa).
 - 3. CWP Rating: 600 psig (4140 kPa).
 - 4. Body: Forged bronze or dezincified-brass alloy.
 - 5. Ends: Threaded.
 - 6. Seats: PTFE.
 - 7. Stem: Stainless steel.
 - 8. Ball: Stainless steel, vented.

2.5 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug Style: Bi-directional dead-end service without use of downstream flange.
 - 1. Comply with MSS SP-67, Type I.
 - 2. CWP Rating: 150 psig (1035 kPa) and 200 psig (1680 kPa).
 - 3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
 - 4. Stem: One or two-piece stainless steel.
 - 5. Seat: NBR.
 - 6. Disc: Coated ductile iron.

2.6 IRON, GROOVED-END BUTTERFLY VALVES

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

2.7 HIGH-PERFORMANCE, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type: Bi-directional dead end service without downstream flange.
 - 1. Comply with MSS SP-68.
 - 2. Class 150: CWP Rating: 285 psig (1965 kPa) and Class 300: CWP Rating: 720 psig (4965 kPa) at 100 degrees F (38 degrees C).
 - 3. Body: Provide carbon steel, cast iron, ductile Iron, or stainless steel.
 - 4. Seat: Metal or reinforced PTFE.

5. Offset stem: Stainless steel.
6. Disc: Carbon steel.

2.8 BRONZE, SWING CHECK VALVES

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

2.9 IRON, FLANGED END SWING CHECK VALVES

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

2.10 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP:
 1. 2 NPS (50 DN) to 8 NPS (200 DN).
 2. CWP Rating: 300 psig (2070 kPa).
 3. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
 4. Seal: EPDM or Nitrile.
 5. Disc: Ductile iron.
 6. Coating: Black, non-lead paint.

PART 3 EXECUTION

3.1 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.

3.2 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.

END OF SECTION

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SECTION 230529**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT-CPL****PART 1 GENERAL****1.1 SECTION INCLUDES**

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

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

1.4 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.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS**2.1 SUPPORT AND ATTACHMENT COMPONENTS**

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

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- a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 2. Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 3. Comply with MFMA-4.
 4. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 5. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm).
 6. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
- D. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch (13 mm) diameter.
 - b. Piping up to 1 inch (27 mm) nominal: 1/4 inch (6 mm) diameter.
 - c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch (10 mm) diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch (10 mm) diameter.
- E. Thermal Insulated Pipe Supports:
 1. Manufacturers:
 - a. Buckaroos, Inc: www.buckaroos.com/#sle.
 - b. KB Enterprises: www.snappitz.com/#sle.
 2. General Construction and Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch (12.7 mm to 762 mm) 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 (Minus 40 degrees C).
 - c. Maximum Service Temperature: 180 degrees F (82 degrees C).
 - d. Moisture Vapor Transmission: 0.0071 perm inch (0.0092 ng/Pa s m), when tested in accordance with ASTM E96/E96M.
 - e. Thickness: 60 mil (1.524 mm).
 - f. Connections: Brush on welding adhesive.
 4. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.
 5. Products:
 - a. Buckaroos, Inc; CoolDry: www.buckaroos.com/#sle.
- F. Pipe Supports:
 1. Liquid Temperatures Up To 122 degrees F (50 degrees C):
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
 2. Operating Temperatures from 122 to 446 degrees F (50 to 230 degrees C):

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- a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.
 - b. Roller Support: MSS SP-58 Types 41 or 43 through 46, with appropriate saddle of MSS SP-58 Type 39 for insulated pipe.
 - c. Sliding Support: MSS SP-58 Types 35 through 38.
- G. Pipe Stanchions: For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
1. Manufacturers:
 - a. Anvil International; H-Block: www.anvilintl.com/#sle.
 2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- H. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
1. Manufacturers:
 - a. Ferguson Enterprises Inc: www.fnw.com/#sle.
 2. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 3. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- I. Riser Clamps:
1. Manufacturers:
 - a. Ferguson Enterprises Inc; _____: www.fnw.com/#sle.
 2. Provide copper plated clamps for copper tubing support.
 3. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- J. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- K. Strut Clamps: Two-piece pipe clamp.
- L. Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- M. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- N. Intermediate Pipe Guides: Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
1. Pipe Diameter 6 inches (150 mm) and Smaller: Provide minimum clearance of 0.16 inch (4 mm).
 2. Pipe Diameter 8 inches (200 mm): Provide U-bolts with double nuts providing minimum clearance of 0.28 inch (7 mm).
 3. Pipe Diameter 8 inches (200 mm): 0.625 inch (16 mm) U-bolt.
 4. Pipe Diameter 10 inches (250 mm): 0.75 inch (19 mm) U-bolt.
 5. Pipe Diameter 12 to 16 inches (300 to 400 mm): 0.875 inch (24 mm) U-bolt.
 6. Pipe Diameter 18 to 30 inches (450 to 750 mm): 1 inch (25 mm) U-bolt.
- O. Pipe Alignment Guides: Galvanized steel.
1. Pipe Diameter 8 inches (200 mm) and Smaller: Spider or sleeve type.
 2. Pipe Diameter 10 inches (250 mm) and Larger: Roller type.
- P. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
- Q. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
1. Manufacturers:
 - a. Anvil International; H-Block: www.anvilintl.com/#sle.

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- b. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - c. Erico International Corporation, a brand of Pentair: www.erico.com/#sle.
 - d. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - e. PHP Systems/Design: www.phpsd.com/#sle.
 - f. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 2. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
 3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 5. Mounting Height: Provide minimum clearance of 6 inches (150 mm) under supported component to top of roofing.
- R. Pipe Shields for Insulated Piping:
 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 2. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch (321 mm).
 - d. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
 - e. Maximum Service Temperature: 178 degrees F (81 degrees C).
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- S. Anchors and Fasteners:
 1. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - c. Powers Fasteners, Inc: www.powers.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - c. Powers Fasteners, Inc: www.powers.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 3. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 6. Hollow Masonry: Use toggle bolts.
 7. Hollow Stud Walls: Use toggle bolts.
 8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 9. Sheet Metal: Use sheet metal screws.
 10. Wood: Use wood screws.
 11. Plastic and lead anchors are not permitted.
 12. Hammer-driven anchors and fasteners are not permitted.
 13. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

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- a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm) minimum base metal thickness.
 - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
14. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
- T. Pipe Installation Accessories:
1. Copper Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 2. Thermal Insulated Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 3. Overhead Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 4. Plenum Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 5. Telescoping Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 6. Inserts and Clamps:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

2.2 RETROFIT PIPING COVER SYSTEM

- A. Manufacturers:
1. DecoShield Systems, Inc: www.decoshield.com/#sle.
- B. General Requirements:
1. Surface Burning Characteristics: Flame spread index/smoke developed index of 20/250, maximum, when tested in accordance with ASTM E84 or UL 723.
- C. Materials:
1. Piping Cover System: Removal-resistant, modular, snap-fit cover units, clips, and anchors for use with CPVC, steel, and copper piping systems.
 2. Cover Units: L-shaped and U-shaped cross-section units of flame retardant resin material, paintable finish.
 3. Unit Length: 7.5 feet (2.29 m).
 4. Provide coupling fittings for joining units end to end and prefabricated inside and outside corner fittings and end caps as required.
 5. Provide mounting clips to secure covers to wall-ceiling per manufacturer requirements.

PART 3 EXECUTION**3.1 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.

3.2 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 (80 mm) 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.

3.3 FIELD QUALITY CONTROL

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

END OF SECTION

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SECTION 230550
WIND RESTRAINT FOR HVAC SYSTEMS**PART 1 GENERAL****1.1 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.

1.2 SECTION INCLUDES

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

1.3 APPLICABLE CODES AND STANDARDS

- A. Provide work in compliance with the following codes and standards:
- B. 2015 International Building Code (Section 1609).
- C. 2015 International Mechanical Code (Section 301, Item 301.15).
- D. American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures with Supplement No. 1 - Standard ASCE/SEI 7-10.

1.4 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.

1.5 SUBMITTALS

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

PART 1 PRODUCTS**2.1 CODE INFORMATION**

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

2.2 WIND BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

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

PART 1 EXECUTION**3.1 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

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT-CPL**PART 1 GENERAL****1.1 SECTION INCLUDES**

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

1.2 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Identification painting.

1.3 REFERENCE STANDARDS

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

1.4 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**2.1 IDENTIFICATION APPLICATIONS**

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

P. Valves: Tags and ceiling tacks where located above lay-in ceiling.

Q. Water Treatment Devices: Nameplates.

2.2 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 (6 mm).

D. Background Color: Black.

E. Plastic: Comply with ASTM D709.

2.3 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 (40 mm) diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 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 (0.76 mm); printed with UV and chemical resistant inks.

C. Style: Individual Label.

D. Color: Green/White Green/White.

2.5 STENCILS

A. Manufacturers:

1. Brady Corporation: www.bradycorp.com/#sle.
2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
3. Insite Solutions, LLC: www.stop-painting.com/#sle.
4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
5. Seton Identification Products, a Tricor Company: www.seton.com/#sle.

B. Stencils: With clean cut symbols and letters of following size:

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1. 3/4 to 1-1/4 inch (20-30 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 1/2 inch (15 mm) high letters.
 2. 1-1/2 to 2 inch (40-50 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 3/4 inch (20 mm) high letters.
 3. 2-1/2 to 6 inch (65-150 mm) Outside Diameter of Insulation or Pipe: 12 inch (300 mm) long color field, 1-1/4 inch (30 mm) high letters.
 4. 8 to 10 inch (200-250 mm) Outside Diameter of Insulation or Pipe: 24 inch (600 mm) long color field, 2-1/2 inch (65 mm) high letters.
 5. Over 10 inch (250 mm) Outside Diameter of Insulation or Pipe: 32 inch (800 mm) long color field, 3-1/2 inch (90 mm) high letters.
 6. Ductwork and Equipment: 2-1/2 inch (65 mm) high letters.
- C. Stencil Paint: As specified in Section 099123, semi-gloss enamel, colors complying with ASME A13.1.

2.6 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.

2.7 CEILING TACKS

- A. Manufacturers:
1. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
- B. Description: Steel with 3/4 inch (20 mm) diameter color coded head.
- C. Color code as follows:
1. HVAC Equipment: Yellow.
 2. Fire Dampers and Smoke Dampers: Red.
 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION**3.1 PREPARATION**

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

3.2 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 (20 mm) 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 (6 m) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with adhesive-backed duct markers. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- H. Locate ceiling tacks to locate dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 230593**TESTING, ADJUSTING, AND BALANCING FOR HVAC-CPL****PART 1 GENERAL****1.1 SECTION INCLUDES**

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

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

5. Units of Measure: Report data in I-P (inch-pound) units only.
6. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

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

3.2 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.

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9. Air outlets are installed and connected.
 10. Duct system leakage is minimized.
 11. Hydronic systems are flushed, filled, and vented.
 12. Pumps are rotating correctly.
 13. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

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

3.4 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.

3.5 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.

3.6 AIR SYSTEM PROCEDURE

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

- G. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- H. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- I. Where modulating dampers are provided, take measurements and balance at extreme conditions.

3.7 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.

3.8 COMMISSIONING

- A. See Sections 019113 - General Commissioning Requirements and 230800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 25 percent of the air handlers plus a random sample equivalent to 10 percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.
 - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 - 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F (0.5 degree C).
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.

5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.9 SCOPE

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

3.10 MINIMUM DATA TO BE REPORTED

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

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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. Air Cooled Condensers:
1. Identification/number.
 2. Location.
 3. Manufacturer.
 4. Model number.
 5. Number of compressors.
- E. Cooling Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Entering air DB temperature, design and actual.
 7. Leaving air DB temperature, design and actual.
 8. Water flow, design and actual.
 9. Water pressure drop, design and actual.
 10. Entering water temperature, design and actual.
 11. Leaving water temperature, design and actual.
 12. Air pressure drop, design and actual.
- F. 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.
- G. Electric Duct Heaters:
1. Manufacturer.
 2. Identification/number.
 3. Location.
 4. Model number.
 5. Design kW.

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6. Number of stages.
 7. Phase, voltage, amperage.
 8. Test voltage (each phase).
 9. Test amperage (each phase).
 10. Air flow, specified and actual.
 11. Temperature rise, specified and actual.
- 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:

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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

SECTION 230713
DUCT INSULATION-CPL

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 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.

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- F. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- G. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation 2020.
- H. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material) 2019.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- K. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).
- L. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- M. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 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.

1.5 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.

1.6 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.

1.7 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

2.1 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.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. JP Lamborn Co; Thermal Sleeve MT: www.jpflex.com/#sle.
 - 4. Knauf Insulation; Atmosphere Duct Wrap: www.knaufinsulation.com/#sle.
 - 5. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K (Ksi) value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F (649 degrees C).
 - 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 (0.029 ng/Pa s m), 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 (1.29 mm diameter).

2.3 GLASS FIBER, RIGID

- A. Manufacturer:

1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 4. Owens Corning Corporation; 700 Series FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. K (Ksi) Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 450 degrees F (232 degrees C).
 3. Maximum Water Vapor Absorption: 5.0 percent.
 4. Maximum Density: 8.0 lb/cu ft (128 kg/cu m).
- C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/Pa s m), 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 (305 g/sq m) weight, glass fabric.
 2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
 2. Maximum Service Temperature: 180 degrees F (82 degrees C).
 3. Connection: Waterproof vapor barrier adhesive.
- B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.5 EXPANDED POLYSTYRENE INSULATION

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

2.6 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd (220 g/sq m) plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
1. Lagging Adhesive:
 - a. Manufacturers:
 - 1) Design Polymeric; DP 3050 Water Based, Zero VOC, Premium Quality, Lagging Adhesive, and Vapor Retarder: www.designpoly.com/#sle.
 - 2) Substitutions: See Section 016000 - Product Requirements
 - b. Compatible with insulation.
- B. Aluminum Jacket: ASTM B209 (ASTM B209M).
1. Thickness: 0.016 inch (0.40 mm) sheet.
 2. Finish: Smooth.

3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
4. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.

2.7 DUCT LINER

- A. Manufacturers:
 1. Armacell LLC; AP Coilflex: www.armacell.us/#sle.
 2. CertainTeed Corporation: www.certainteed.com/#sle.
 3. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 4. Johns Manville: www.jm.com/#sle.
 5. Knauf Insulation: www.knaufinsulation.com/#sle.
 6. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 7. Substitutions: See Section 016000 - Product Requirements.
- B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
 2. Maximum Service Temperature: 180 degrees F (82 degrees C).
 3. Fungal Resistance: No growth when tested according to ASTM G21.
 4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F (0.045 at 24 degrees C).
 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch (25 mm) Thickness: 0.40.
 6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm (50.8 m/s) per ASTM C1071.
 7. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated Ducts Conveying Air Below Ambient Temperature:
 1. Provide insulation with vapor barrier jackets.
 2. Finish with tape and vapor barrier jacket.
 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- D. Insulated Ducts Conveying Air Above Ambient Temperature:
 1. Provide with standard vapor barrier jacket.
 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor) ((below 3 meters above finished floor)): Finish with canvas jacket sized for finish painting.

- F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.
- G. Slope exterior ductwork to shed water.
- H. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
- I. Duct and Plenum Liner Application:
 - 1. Adhere insulation with adhesive for 90 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 - 3. Seal and smooth joints. Seal and coat transverse joints.
 - 4. Seal liner surface penetrations with adhesive.
 - 5. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.

3.3 SCHEDULES

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

1. Insulation: **Top of duct shall be slanted to shed water.**
 - a. Expanded Polystyrene Insulation.
 - 1) Thickness required to provide an R value not less than R-12.
2. Jacket:
 - a. Alumaguard® flexible weather-proofing jacket, self-healing membrane on exterior duct-work. Install per manufactures recommendations.

END OF SECTION

SECTION 230719
HVAC PIPING INSULATION-CPL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus 2019.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- D. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- E. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).
- F. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement 2007 (Reapproved 2019).
- G. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- H. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.
- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2023).
- J. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation 2023.
- K. ASTM D610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces 2008 (Reapproved 2019).
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- M. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 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.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 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

2.1 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.

2.2 GLASS FIBER, RIGID

- A. Manufacturers:
1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville Corporation: www.jm.com/#sle.
 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation: www.knaufinsulation.com/#sle.
 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
 5. Owens Corning Corporation; VaporWick Pipe Insulation: www.ocbuildingspec.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
1. K (Ksi) Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
 2. Maximum Service Temperature: 850 degrees F (454 degrees C).
 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
1. K (Ksi) Value: ASTM C177, 0.23 at 75 degrees F (0.034 at 24 degrees C).
 2. Maximum Service Temperature: 220 degrees F (104 degrees C).
 3. Maximum Moisture Absorption: 0.2 percent by volume.
- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches (0.029 ng/Pa s m).
- E. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
- F. Vapor Barrier Lap Adhesive: Compatible with insulation.
- G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- H. Fibrous Glass Fabric:
1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 2. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
 3. Weave: 5 by 5.

- I. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, black color.
- J. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- K. Insulating Cement: ASTM C449.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Aeroflex USA, Inc; Aerocel Stay-Seal with Protape (SSPT): www.aeroflexusa.com/#sle.
 - 2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
 - 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
 - 2. Maximum Service Temperature: 180 degrees F (82 degrees C).
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F (minus 18 degrees C).
 - b. Maximum Service Temperature: 150 degrees F (66 degrees C).
 - c. Moisture Vapor Permeability: 0.002 perm inch (0.0029 ng/Pa s m), maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil (0.25 mm).
 - e. Connections: Brush on welding adhesive.
 - 3. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch (0.40 mm) sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
 - 4. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.
- C. Vapor Barrier Membranes: ASTM C1136, Type IX.
 - 1. Multilayer Laminate Vapor Barrier:
 - a. Thickness: 2.4 mil (0.06 mm).
 - b. Moisture Vapor Permeability: 0.00 perm inch (0.00 ng/Pa s m), when tested in accordance with ASTM E96/E96M.
 - c. Manufacturers:
 - 1) Polyguard Products; ZERO-PERM: www.polyguardproducts.com/#sle.
 - 2) Substitutions: See Section 016000 - Product Requirements.

2.5 ACCESSORIES

- A. General Requirements:
 - 1. Provide required accessories in accordance with and subject to the recommendations of the insulation manufacturer.
 - 2. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
 - 3. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
 - 4. Supply materials that are asbestos free.
- B. Corrosion Inhibitors:
 - 1. Corrosion Control Gel:
 - a. Manufacturers:
 - 1) Polyguard Products; RG2400LT: www.polyguardproducts.com/#sle.
 - 2) Substitutions: See Section 016000 - Product Requirements.
 - b. Corrosion Protection: Comply with ASTM B117 and ASTM D610.

PART 3 EXECUTION

3.1 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.

3.2 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 (60 degrees C) 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 (60 degrees C), 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 (40 mm) 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 (150 mm) 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 (3 meters) 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.

3.3 SCHEDULE

- A. Heating Systems:
 - 1. Heating Water Supply and Return:
 - a. NPS 1-1/4 and Smaller: 1-1/2 inch thick Rigid Glass Fiber.
 - b. NPS 1-1/2 and Larger: 2 inch thick Rigid Glass Fiber.
- B. Cooling Systems:
 - 1. Cold Condensate Drains:
 - a. All Sizes: 1/2 inch thick Rigid Glass Fiber with Vapor Barrier.
 - b. All Sizes: 3/4 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
 - 2. Condensate Drains from Cooling Coils:
 - a. All Sizes: 1/2 inch thick Rigid Glass Fiber with Vapor Barrier.
 - b. All Sizes: 3/4 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
 - 3. Refrigerant Suction:
 - a. All Sizes: 1-1/2 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
 - 4. Refrigerant Hot Gas:
 - a. All Sizes: 1-1/2 inch thick Flexible Elastomeric Cellular with Vapor Barrier.
- C. Outdoor Systems:
 - 1. Refrigerant Suction and Hot Gas:
 - a. All Sizes: 2 inch thick Flexible Elastomeric Cellular with Vapor Barrier and Aluminum Jacket.

END OF SECTION

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SECTION 230913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**PART 1 GENERAL**

- ALTERNATE MC-01 - PROVIDE NEW FULL BUILDING CONTROLS AND ALL ASSOCIATED COMPONENTS TO HAVE A NEW HEAD END AND FULLY OPERATIONAL SYSTEM.

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

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

4.1 SECTION INCLUDES

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

4.2 RELATED REQUIREMENTS

- A. Section 230519 - Meters and Gauges for HVAC Piping-CPL: Thermometer sockets and gauge taps.

- B. Section 230923 - Direct-Digital Control System for HVAC.
- C. Section 230993 - Sequence of Operations for HVAC Controls.

4.3 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating 2018.
- B. ANSI/FCI 70-2 - Control Valve Seat Leakage 2021.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- D. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats 2013.

4.4 ADMINISTRATIVE REQUIREMENTS

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

4.5 SUBMITTALS

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

4.6 QUALITY ASSURANCE

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

4.7 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

5.1 EQUIPMENT - GENERAL

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

5.2 CONTROL PANELS

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

C. Provide common keying for all panels.

5.3 CONTROL VALVES

A. Ball Valves and Actuators:

1. Service: Use for chilled water, hot water, or steam at 15 to 25 psig (104.4 to 172.4).
2. Flow Characteristic: Include 2-way, 3-way diverting, and 3-way mixing operation.
 - a. Heating Hot Water: Configure to fail normally open.
 - b. Chilled Water: Configure to fail normally closed.
3. Provide pressure-independent type.
4. Rangeability: 500 to 1.
5. ANSI Rating: Class 150.
6. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
7. Body Size:
 - a. Under 2-1/2 inches (64 mm):
 - 1) Connection: NPT.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - b. 2-1/2 inches (64 mm) and Above:
 - 1) Connection Type: Flanged.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - c. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F (0 to 140 degrees C) liquid or 25 psig (172.4 kPa) steam.
 - 2) Ambient Side: From minus 4 to 122 degrees F (minus 20 to 50 degrees C).
8. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Input: 0 to 5 VDC configured for proportional control.
 - c. Accessories: Provide with valve position indicator and manual override.

B. Globe Pattern:

1. Up to 2 inches (50 mm): Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
2. Over 2 inches (50 mm): Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.

C. Electronic Operators:

1. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.

2. Select operator for full shut off at maximum pump differential pressure.

D. Radiation Valves:

1. Size for 3 psig (20 kPa) maximum pressure drop at design flow rate.
2. Operators (Modulating): Self-contained, linear motorized actuator with approximately 3/4 inch (19 mm) stroke, 60 second full travel with transformer and SPDT contacts: 24 v DC, 6 watt maximum input.

5.4 DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gauge, 0.1046 inch (2.66 mm).
- C. Blades: Galvanized steel, maximum blade size 8 inches (200 mm) wide, 48 inches (1200 mm) long, minimum 22 gauge, 0.0299 inch (0.76 mm), attached to minimum 1/2 inch (13 mm) shafts with set screws.
- D. Blade Seals: Synthetic elastomeric, inflatable, mechanically attached, field replaceable.
- E. Shaft Bearings: Oil impregnated sintered bronze.
- F. Linkage Bearings: Oil impregnated sintered bronze.
- G. Leakage: Less than one percent based on approach velocity of 2000 ft per min (10 m per sec) and 4 inches wg (1.0 kPa).
- H. Maximum Pressure Differential: 6 inches wg (1.5 kPa).
- I. Temperature Limits: Minus 40 to 200 degrees F (Minus 40 to 93 degrees C).

5.5 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 2. Provide one operator for maximum 36 sq ft (3.34 sq m) damper section.
- B. Electric Operators:
 1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

5.6 HUMIDISTATS

- A. Limit Duct Humidistats:
 1. Insertion, two position type.
 2. Throttling Range: Adjustable 2 percent relative humidity.
 3. Operating Range: 20 to 80 percent.
 4. Maximum Temperature: 150 degrees F (65 degrees C).

5.7 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F (26 degrees C).
 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 (0.28 degrees C) minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F (0.42 degrees C) minimum.
 - 5) Range: Minus 40 degrees F (Minus 40 degrees C) through 220 degrees F (104.4 degrees C) minimum.
 - b. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F (0.20 degrees C) minimum.
 - 2) Range: Minus 25 degrees F (Minus 13 degrees C) through 122 degrees F (50 degrees C) minimum.
 - 3) Heat Dissipation Constant: 2.7 mW per degree C.
 - c. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F (0.06 degrees C) minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 to 20 mA.
 - d. Room Sensors: Locking cover.
 - e. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - f. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
 - g. Room Temperature Sensors with Integral Digital Display:
 - 1) Construct for wall box.
 - h. Temperature Averaging Elements:
 - 1) Use on duct sensors for ductwork 10 sq ft (0.93 sq m) or larger.
 - 2) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
 - i. Insertion Elements:
 - 1) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches (60 mm).
- B. Humidity Sensors:
 1. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.
 - a. Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.
 - b. Input Power, mA Type: Class 2; Loop powered 12-30 VDC only, 30 mA max.
 - c. Output Voltage Type: 3-wire observed polarity.
 - d. Output mA Type: 2-wire, not polarity sensitive (clipped and capped).
 - e. Humidity:
 - 1) HS Element: Digitally profiled thin-film capacitive.
 - 2) Accuracy 1 percent at 10 to 80 percent relative humidity at 77 degrees F (25 degrees C), multi-point calibration, NIST traceable.
 - (a) Plus/minus 1 percent at 20 to 40 percent RH in mA output mode; (multi-point calibration, NIST traceable).
 - 3) Scaling: 0 to 100 percent RH.
 - f. Temperature Effect:
 - 1) Duct Mounted: Plus/minus 0.18 percent per degree F (Plus/minus 0.10 percent per degree C).
 - 2) Outdoor Mounted: 4 to 20mA version: $(0.0013 \times \%RH \times (T_{\text{degreeC}} - 25))$.
 - g. Hysteresis: 1.5 percent typical.
 - h. Linearity: Included in accuracy specification.
 - i. Reset Rate: 24 hours.
 - j. Stability: Plus/minus 1 percent at 68 degrees F (20 degrees C) annually, for two years.

- k. Temperature Monitoring:
 - 1) Temperature Transmitter Output: Digital, 4 to 20mA (clipped and capped) or 0-5V/0-10V output.
 - (a) HO Transmitter Accuracy: Plus/minus 2.3 degrees F (Plus/minus 1.3 degrees C).
 - (b) HD Transmitter Accuracy: Plus/minus 1.0 degree F (Plus/minus 0.5 degrees C).
 - l. Operating Environment:
 - 1) Operating Humidity Range: 0 to 100 percent RH noncondensing.
 - 2) Operating Temperature Range: Minus 40 degrees F (Minus 40 degrees C) to 122 degrees F (50 degrees C).
- C. Static Pressure (Air Pressure) Sensors:
 - 1. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F (5 to 40 degrees C).
 - 2. Accuracy: One percent of full scale with repeatability 0.3 percent.
 - 3. Output: 0 to 5 vdc with power at 12 to 28 vdc.
- D. Equipment Operation (Current) Sensors:
 - 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg (0 to 1250 Pa).
 - 2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi (50 to 400 kPa).
 - 3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- E. Carbon Monoxide Sensors, for Single-Gang Electrical Box Mounting:
 - 1. General:
 - a. Input Power: Class 2; 15 to 30 VDC/24 VAC plus/minus 20 percent, 50/60 Hz.
 - b. Relay Ratings: 1A/30VAC/DC, normally open.
 - c. Operating Temperature Range: Minus 4 degrees F (Minus 20 degrees C) to 122 degrees F (50 degrees C).
 - d. Operating Humidity Range: 0 to 90 percent RH non-condensing.
 - e. Terminal Block Wire Size: 30 AWG (0.255 mm) by 12 AWG (2.05 mm).
 - f. Terminal Block Torque: 0.37 to 0.44 inch-lbf (0.5 to 0.6 N-m).
 - g. Protection Class: IP20 in accordance with IEC 60529.
 - 2. Sensor:
- F. Carbon Dioxide Sensors, Duct and Wall:
 - 1. Calibration Characteristics:
 - a. Automatically compensating algorithm for sensor drift due to sensor degradation.
 - b. Maximum Drift: 2 percent.
 - c. User calibratable with a minimum calibration interval of 5 years.
 - 2. Construction:
 - a. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
 - b. Housing: High impact plastic.

5.8 THERMOSTATS

- A. Electric Room Thermostats:
 - 1. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
- B. Room Thermostat Accessories:
- C. Outdoor Reset Thermostats:
 - 1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.

- D. Immersion Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- E. Electric Low Limit Duct Thermostats:
- F. Electric High Limit Duct Thermostats:
 - 1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above setpoint,

5.9 TIME CLOCKS

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

PART 3 EXECUTION

6.1 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.

6.2 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 (1500 mm) 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.

6.3 MAINTENANCE

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

END OF SECTION

SECTION 230923
DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

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

1.3 DESCRIPTION OF WORK

- A. **ALTERNATE MC-01 - PROVIDE NEW FULL BUILDING CONTROLS AND ALL ASSOCIATED COMPONENTS TO HAVE A NEW HEAD END AND FULLY OPERATIONAL SYSTEM.**
- B. **BASE BID - PROVIDE CONTROLS FOR THE NEW EQUIPEMENT THAT IS COMPATTIBLE WITH FUTURE BACNET UPGRADES AND THE CURRENT BMS.**
- C. Furnish all labor, materials, equipment, and service necessary to extend the existing building operation Digital Control System and provide a complete and operating temperature control system. System shall use Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein. Control sequences are specified on plans.
1. All actuation of valves and dampers shall be electric unless specifically called out elsewhere in the specifications or drawings.
- D. In accordance to the scope of work, the system shall provide a scalable vector-based graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability and allowing future expansion of both input/output points and processing/control functions.
- E. For this project, the system shall consist of the following components:
1. Administration and Programming Workstation(s): The BAS Contractor shall furnish (qty 1) Administration and Programming Workstation Computers as described "Administrative/Programming Workstation & Enterprise Server Requirements" section of this specification. These workstation(s) must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third-party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.

2. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control set points and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the workstation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer-based hardware to support the web-based user interface.
 3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish Ethernet-based Network Server Controllers. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted.
 4. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Network Server Controllers (B-BC).
 5. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC.
 6. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).
- F. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBAud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2008, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2008, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.
- G. The software tools required for network management of the ANSI / ASHRAE™ Standard 135-2008, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner.
- H. The system shall support Modbus TCP and RTU protocols natively, and not require the use of gateways.
- I. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.
1. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
 2. Data shall reside on a supplier-installed server for all database access.
 3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.

1.4 ACTION SUBMITTALS

- A. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical schematics will be allowed where appropriate.
 - 1. Each drawing containing an equipment schematic shall contain a table indicating what equipment is covered by this drawing (i.e. equipment "tag #") and which drawing in the Construction Document set this piece of equipment is shown on.
- B. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.
- C. Submittal data shall contain descriptions of sequences of operation.
- D. Submit a digital copy of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. Prior to submitting, the Contractor shall check all documents for accuracy.
- E. The Engineer will make corrections, if required, and return to the Contractor. The Contractor shall then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
- F. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS shall be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- G. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. See Section 3.6 for detail required in Commissioning the system.
- H. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. All labor, material, equipment and software necessary to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be provided by Day Automation Systems. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner. This contractor also is responsible for all costs of changes in the work required by substitute equipment.

- B. The Building Management System (BMS) Contractor must have been in business for not less than 10 years and providing BMS systems must be the Contractor's primary business. BMS Contractor must be an authorized distributor or branch office of the manufacturers specified. BMS Contractor must have a trained staff of application engineers, project managers, software engineers, commissioning staff, and service staff experienced in the configuration, programming and service of the automation system.
- C. The BMS Contractor shall have a training facility with regularly scheduled training to provide ongoing regularly scheduled application training.
- D. Manufacturer: A firm regularly engaged in manufacture of microprocessor temperature control equipment, of types and sizes which are similar to required equipment, and which have been in satisfactory use for not less than 10 years, in similar service.
- E. Electrical standards: Provide electrical products that comply with the following agency approvals:
 - 1. UL-916; Energy Management Systems for BAS components and ancillary equipment
 - 2. UL-873; Temperature Indication and Regulating Equipment
 - 3. FCC, Part 15, Subpart J, Class A Computing Devices
- F. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

1.7 WARRANTY AND ACCEPTANCE

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

PART 2 PRODUCTS

2.1 DDC SYSTEM MANUFACTURERS

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

2.2 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 SCOPE OF WORK

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

2.4 SYSTEM ARCHITECTURE

- A. General
 - 1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
 - 2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
 - 3. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.

4. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP and/or Modbus TCP protocol. All protocols shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow both protocols to be natively supported.
A sub-network of SDCUs using the BACnet MS/TP and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.
- B. TCP/IP Level
 1. The TCP/IP layer connects all the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.
- C. Fieldbus Level with Standalone Digital Control Units (SDCUs)
 1. The fieldbus layer shall be supporting all the following types of SDCUs:
 - a. BACnet SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 50 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2007
 - b. Modbus SDCU requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Server Controller. The field bus layer shall consist of up to 62 SDCUs for operation of HVAC, power metering, and lighting equipment. If utilizing Modbus TCP, the field bus layer shall consist of up to 100 SDCUs for operation of HVAC, power metering, and lighting equipment.
- D. Standard Network Support
 1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.
- E. Support For Open Systems Protocols
 1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.5 OPERATOR WORKSTATION REQUIREMENTS

- A. General
 1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 10 concurrent operator users and/or 1 engineering users within the enterprise server.
 2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
 3. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system (specified below). The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.

4. A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC.
- B. Administration/Programming Workstation & Enterprise Server Requirements
1. The Enterprise Server shall consist of the following:
 - a. Processor
 - 1) GHz or higher
 - b. Memory
 - 1) 4GB or higher
 - c. Operating systems:
 - 1) Microsoft Windows XP Pro 32-bit SP3
 - 2) Microsoft Windows 7 Pro 32-bit
 - 3) Microsoft Windows 7 Pro 64-bit
 - 4) Microsoft Windows 2008 R2 64-bit
 - 5) 10/100MBPS Ethernet NIC
 - 6) 250 GB hard disk
 - 7) License agreement for all applicable software
 2. The workstation shall consist of the following:
 - a. Processor
 - 1) GHz or higher
 - b. Memory
 - 1) 4GB or higher
 - c. Operating systems:
 - 1) Microsoft Windows XP Pro 32-bit SP3
 - 2) Microsoft Windows 7 Pro 32-bit
 - 3) Microsoft Windows 7 Pro 64-bit
 - 4) Microsoft Windows 2008 R2 64-bit
 - 5) Serial port, parallel port, USB port
 - 6) 10/100MBPS Ethernet NIC
 - 7) 20 GB hard disk
 - 8) DVD drive
 - 9) High resolution (minimum 1280 x 1024), 17" flat panel display
 - 10) Optical mouse and full function keyboard
 - 11) Audio sound card and speakers
 - 12) License agreement for all applicable software.
- C. Web-Based Operator PC Requirements
1. Any user on the network can access the system, using the following software:
 - a. Windows 2000/XP and above
 - b. Internet Explorer 8 (32-bit)
 - c. Internet Explorer 9 (32-bit)
 - d. Firefox 4.0 (32-bit) and above
 - e. Java-enabled
- D. User Interface:
1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software.

- E. The building operation user interface will be used as the graphical user interface to represent all live system data, schedule adjustment and alarm annunciation from devices installed by an energy management contractor.
- F. The user interface will include the following graphical screens and features as a minimum:
1. A main screen for the building which will include global commands to adjust the occupied and unoccupied building set points for the entire building. Hyperlinks to open space temperature reports and fan run indication status reports will also be included.
 2. AutoCAD files will be imported into the user interface to create floor plan graphics. Each piece of mechanical equipment will be represented on the floor plan with a color coded tag denoting its type (i.e. AHU, UV, FCU, VAV, Boiler, Heat Pump, Exhaust Fan, Radiation or CUH). Live space temperature data will be displayed in the associated room containing the space temperature sensor. Clicking on the live space temperature value will open a schematic of the mechanical equipment.
 3. Each piece of controlled mechanical equipment will have a dedicated user interface screen. An engineering style ductwork diagram will be provided for all air systems. An engineering style piping diagram will be provided for all hot water and chilled water systems. The ductwork and piping diagrams will be accurate representations to the piping or ductwork installed.
 4. The mechanical equipment graphic will display the current operating mode (occupied, unoccupied, warm-up or cool-down), a summary of associated alarms, the scheduled time of operation, set point adjustment information, and operator override timer information.
 5. Every system input, output and control point will accumulate historical trend data for a minimum of 24 hours. An option to collect data for extended period of time (i.e. 1 year) will also be available on every point. A report of the historical trend data will be available as a link from the mechanical equipment graphic.
 6. Alarm alerts will be configured for the following conditions as a minimum
 - a. Fan/Pump run indication failure
 - b. Fan/Pump stop failure
 - c. Space temperature high
 - d. Space temperature low
 - e. Low hot water supply temperature
 - f. Boiler alarm
 - g. Pump/Fan VSD alarm
 - h. Each associated alarm will contain a detailed message describing the alarm condition.
 7. A reporting engine will be included at no additional charge to create ad hock reports on alarms, system activity, and live system values. The reporting engine will offer an option for the operator to adjust the search criteria.
 8. Ten equipment schedules will be created for each building. Each piece of mechanical equipment will be assigned to one of the ten equipment schedules. The operator will be able to change the equipment schedule assignment from the graphical user interface. Each of the ten equipment schedules will have an option to either subscribe or not subscribe to the holiday schedule.
- G. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.
- H. Automatic monitoring
1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user configurable.
- I. Alarm Management
1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
 2. Alarm management features shall include:
 - a. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
 - b. Playing an audible sound on alarm initiation or return to normal.
 - c. Sending an e-mail anyone listed in a workstation's e-mail account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required, and no email client software must be running in order for email to be distributed.
 - d. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
 - e. An operator shall have the capability to assign an alarm to another user of the system. Such assignments shall be tracked to insure alarm response.
- J. Report Generation
1. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
 2. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future use.
 3. All reports shall be able to be set up to automatically run or be generated on demand.
 4. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
 5. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
 6. Minimum supplied reports shall include:
 - a. Activities Per Server Report
 - b. Activities Per User Report
 - c. Alarm Amount by Category Report

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- d. Alarm Amount by Type Report
 - e. Alarms Per Sever Report
 - f. Current Alarm Report
 - g. Most Active Alarm Report
 - h. System Errors Per Server Report
 - i. Top Activities Report
 - j. Top Alarms Report
 - k. Top System Errors Report
 - l. Trend Log Comparison Report
 - m. User Logins Report
 - n. Users and Groups Reports
- K. Scheduling
- 1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
 - 2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
 - 3. Schedules shall be programmable for a minimum of one year in advance.
- L. Programmer's Environment
- 1. Programming in the NSC shall be line-programming format.
 - 2. It shall be possible to save custom programs as libraries for reuse throughout the system.
 - 3. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple drag and drop actions without the need of complicated programming.
- M. Audit Trail
- 1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
 - 2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
- N. Web-based Operator Software
- 1. General:
 - a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
 - b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
 - 2. Graphic Displays
 - a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
 - b. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
 - 3. Alarm Management
 - a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.

- b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser.
 - O. Groups and Schedules
 - 1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
 - 2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.
 - P. User Accounts and Audit Trail
 - 1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
 - 2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.
- 2.6 NETWORK SERVER CONTROLLERS (NSCS)**
- A. The BACnet NSC shall be classified as a “native” BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).
 - B. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.
 - C. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.
 - D. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization by means of an Internet site including automatic synchronization
 - 6. Native integration of Modbus controller data or BACnet controller data and Modbus controller data
 - E. Hardware Specifications
 - 1. Memory:
 - a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
 - 2. Each NRC shall provide the following on-board hardware for communication:
 - a. One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet
 - b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
 - c. One Device USB port
 - d. Two host USB Ports

- F. Automatic Restart After Power Failure:
1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.
- G. Battery backup:
1. The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.
- H. User Programming Language:
1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be a script-based structured text and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of the script programs.
 2. Network Server Controllers that use a "canned" program method will not be accepted.
- I. NSCs shall have the ability to perform any or all the following energy management routines:
1. Time of Day Scheduling
 2. Calendar Based Scheduling
 3. Holiday Scheduling
 4. Temporary Schedule Overrides
 5. Optimal Start
 6. Night Setback Control
 7. Enthalpy Switchover (Economizer)
 8. Peak Demand Limiting
 9. CFM Tracking
 10. Heating/Cooling Interlock
 11. Hot/Cold Deck Reset
 12. Hot Water Reset
- J. History Logging:
1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
 2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
 3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
 4. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
- K. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
 2. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
 3. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
 4. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.
- L. Embedded Web Server
1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

2.7 BACNET FIELDBUS AND BACNET SDCUS

- A. Networking
1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
 2. IP To Field Bus Routing Devices
 - a. A Network Server Controller shall be used to provide this functionality.
 - b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
 - c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.
- B. Field Bus Wiring and Termination
1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
 2. Each field bus shall have a termination resistor at both ends of each segment.
- C. Repeaters
1. Repeaters are required to connect two segments.
 2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space
- D. Field Bus Devices
1. General Requirements
 - a. Devices shall have a light indicating that they are powered.
 - b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
 - c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.
- E. Network Server Controllers (NSCs)
1. Shall be BTL certified.
- F. Advance Application Controllers (B-AAC)
1. Shall be BTL certified.

2.8 ELECTRICAL POWER DEVICES

- A. Transformers:

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

2.9 IDENTIFICATION

A. Valve Tags:

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

2.10 DDC SENSORS AND POINT HARDWARE

A. General: Where indicated on the drawings, schedules or sequence of operations, provide equipment that conforms to the following specifications:

B. Temperature Sensors:

1. All temperature devices shall use precision thermistors accurate to $\pm 0.36^{\circ}\text{F}$ over a range of -30 to 230°F .
2. Standard space sensors shall be provided in an off-white enclosure for mounting on a standard electrical box.
3. Where manual override of unoccupied mode of control is indicated on the drawings or sequence of operation, provide a push button for selecting after hours operation.
4. Where manual adjustment to the setpoint is indicated on the drawings or sequence of operation, provide slider with $\pm$ programmable scale
5. Where a local display is indicated on the drawings or sequence of operation, the sensor shall incorporate LCD display for viewing the space temperature.
6. Where digital setpoint adjustment and/or other operator selectable parameters are indicated on the drawings or sequence of operation, provide a sensor with built in buttons and digital display. The sensor shall be programmable to provide custom function as specified.
7. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless-steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified.
8. Averaging sensors shall be employed in all mixing plenum applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
9. Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.

C. Humidity Sensors:

1. Humidity sensors shall be polymer resistance type.
2. Space humidity sensors shall have a sensing range of 05 to 95% with accuracy of $\pm 2\%$ RH.
3. Duct sensors and Outdoor air humidity sensors shall have a sensing range of 05 to 95% RH with accuracy of $\pm 3\%$ RH. Sensors shall be suitable for ambient temperature conditions of -40 to 212°F .
4. Equipment shall be able to demonstrate that accuracy is NIST traceable calibration.

D. Pressure Sensors:

1. Air pressure or differential air pressure measurements in the range of 0 to 10" water column shall be accurate to $\pm 1\%$ of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Setra model C-264.

2. Liquid pressure or differential liquid pressure measurements shall be accurate to $\pm 0.25\%$ of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-230.
 3. Steam pressure measurements shall be accurate to $\pm 0.13\%$ of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-207.
- E. Airflow Probes:
1. Provide an array of airflow traverse probes where indicated, capable of continuously monitoring the fan or duct capacities (CFM) they serve. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s) and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30° . Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for HVAC duct installation.
 2. The airflow traverse probe shall not induce a pressure drop in excess of $0.03''$ w.c. at 2000 FPM, nor measurably contribute to sound levels within the duct. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular duct) or at equal concentric area centers (for circular ducts) along the probe length. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of total and static pressure without need for flow corrections or factors, with an accuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.
 3. Provide the minimum number of probes indicated: Duct height 8 – 12'', 1 probe; 13 – 30'', 2 probes; 31 – 54'', 3 probes; 55 – 84'', 4 probes; 85 – 120'', 5 probes; 121 – 180'', 6 probes.
 4. The airflow traverse probe shall be the VOLU-probe as manufactured by Air Monitor Corporation, or equivalent.
- F. Liquid Flow Measurement:
1. Hi Liquid flow measurement devices shall be accurate to $\pm 0.75\%$ over a turn down ratio of 10:1. Insertion probe sensing element shall be made of 316l stainless steel. The sensing element shall have an elliptical shape that eliminates the separation point at a fixed or variable location ahead of the static pressure pick up point. Device shall only require one welded insert mounted to piping system. Acceptable manufacturer shall be Preso, model BAR.
- G. High Limit Thermostats:
1. High limit thermostats shall be located as directed and shall be manual reset type set at 120°F in the return and 180°F in the discharge. Thermostats shall be double pole so as to provide input capability for alarm at the BAS.
- H. Low Limit Thermostats:
1. Safety low limit thermostats shall be vapor pressure type with a 20-foot minimum element. Element shall respond to the lowest temperature sensed by any one-foot section. Provide one thermostat for each 25 square foot of coil area.
 2. Low limit thermostat shall be manual reset and shall be double pole so as to provide input capability for alarm at the BAS.
- I. Current Sensing Status Switches
1. Current status switches shall be used to monitor the run status of fans, pumps, motors and electrical loads. Acceptable manufacturer is Veris or approved equal.

J. Current Measurement Devices

1. Measurement of three-phase power shall be accomplished with a kW/kWh transducer. The instrument shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWh). Provide Veris Model 6000 Power Transducer or approved equal.

K. Carbon Monoxide and Carbon Dioxide Sensing Devices

1. Space or duct mounted carbon dioxide (CO₂) sensor shall be a dual element thermally compensated Lithium Tantalate IR detector and shall contain an on board relay with field adjustable trip point and adjustable time delay. The sensor shall monitor CO₂ over a range of 0 – 3000 PPM, have an accuracy of +/-3% and operate within the range of 32-104°F and 0-95% RH. The sensor shall have a calibration accuracy of 0.5%, a repeatability of no more than +/-20 PPM and a drift of no more than +/-2%. The sensor shall have a green LED for normal operation, and a red LED for relay, and a reset button. Where required by the drawings or specifications, provide an LCD display for displaying PPM level and field adjustable settings. Greystone Product # CDD or equivalent.
2. Wall mounted carbon monoxide (CO) sensor shall be microprocessor based (12-bit accuracy) and shall monitor CO over a range of 0-300 PPM (optional 200-500 PPM). The device shall have an accuracy of +/-3% (electrochemical type) or +/-5% (solid state type) and operate within the range of 32-122°F and 0-95% RH. The sensor shall have a calibration accuracy of 0.5%. Where required by the drawings or specifications, provide an LCD display for displaying PPM level and system configuration information and/or audible alarm with programmable trip point and disable jumper. Greystone Product # CMD or equivalent.

L. Refrigerant Loss Monitor

1. Provide infrared refrigerant loss monitor to allow compliance with ASHRAE 15. Monitor shall detect all halogen-based refrigerants, and refrigerant types shall be field changeable without recalibration. Monitor shall provide continuous digital display of system status and shall provide analog output for remote monitoring. Provide system malfunction detection and indication, and visual alarm indication. SenTech Series IR-SNIF or equivalent.

M. Control Valves

1. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves that mate and match the material of the connected piping.
2. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Valves shall be selected to provide an initial pressure drop of not more than 4 psig for water applications. For low pressure steam application, the pressure drop shall be equal to the supply pressure minus the heating element design inlet pressure.
3. Trim material shall be stainless steel.
4. Normal position of both heating and cooling valves shall be open. Three Way valves shall be piped to fail open to both heating and cooling.
5. Electric Bi-Directional actuators are acceptable on VAV Terminal Units and Reheat coil valve control if so noted.
6. All electric actuators for applications other than VAV terminal units and Reheat Coil valve Control shall be Proportional analog 4-20Ma or 0-10Vdc input and shall be positioned to reflect the output value of the computer control system and shall be spring return to normal position.

N. Dampers

1. Automatic dampers furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers shall be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
 2. Damper frames shall be hat shaped channel, 4" deep constructed of 16-gauge galvanized steel. Stainless steel side seals, and sintered bronze, oil-impregnated bearings shall also be provided.
 3. Damper blades shall be 16-gauge galvanized steel and shall be 6" on center. Provide vinyl-grip seals on blades.
 4. Provide damper linkage that consists of 0.50" diameter steel, cadmium plated and chromate treated pivots. Provide a 1/4-20 set-screw with a locking-patch to lock the pivots to a 0.31 diameter aluminum rod. Pivots shall rotate in a Celcon bearing. Blade brackets shall be 12-gauge cadmium plated steel. Blades shall be individually factory adjusted for maximum shut off.
 5. Provide axles that are steel, 0.350" diameter cadmium plated and driveshafts that are 1/2" diameter cadmium plated steel, extendable 6".
 6. For high performance applications, control dampers shall meet or exceed the UL Class I leakage rating.
 7. Control dampers shall be Ruskin, Arrow or approved equal.
 8. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control.
- O. Electric Thermostats: Provide a low voltage thermostat for control of single zone heating and air conditioning unit as specified in the sequence of operation. Electric thermostats shall include a display of the current space temperature as well as a mechanism for adjusting the setpoint locally. Aquastats on unit heaters shall stop the fan when the water temperature is below 100°F. The control contractor may provide full DDC control of the unit heaters in lieu of electric thermostats and use the global water temperature for low temperature interlock if it is offered at no change in price.

PART 3 EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

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

3.2 WORK BY OTHERS

- A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment specified in this section for installation by the Mechanical Contractor.

- C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
1. Automatic Control Dampers
 2. Automatic Control Valves.
 3. Temperature Sensing Thermal Wells
 4. Pressure Control Sensing Taps

3.3 WIRING, CONDUIT AND CABLE

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

3.4 HARDWARE INSTALLATION

- A. Installation Practices for Field Devices
1. Actuators shall be firmly mounted to give positive movement, and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the actuator stroke.
 2. Actuators shall be stroked ~5%, tightened and returned to normal position to give a positive seal.
 3. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
 4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
 5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
 6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. The low pressure port shall be piped to the outside of the building.
- B. Enclosures:

1. For all I/O requiring field interface devices, these devices where practical shall be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust and moisture and conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. All locks shall be keyed identically.
4. All outside mounted enclosures shall meet the NEMA-4 rating.

3.5 SOFTWARE INSTALLATION

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

3.6 EXISTING CONTROL DEVICES

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

3.7 COMMISSIONING AND SYSTEM STARTUP

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

3.8 TRAINING

- A. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel.
- B. The BAS Contractor shall have a dedicated training center with a minimum of 8 permanent workstations connected to a simulated system.

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

END OF SECTION

SECTION 230934
VARIABLE-FREQUENCY MOTOR CONTROLLERS-CPL**PART 1 GENERAL****1.1 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.

1.2 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.

1.3 REFERENCE STANDARDS

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

1.4 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.

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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.

1.5 SUBMITTALS

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

1.6 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 (320 km) of project site.

1.7 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.

1.8 FIELD CONDITIONS

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

1.9 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**2.1 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.

2.2 VARIABLE-FREQUENCY MOTOR CONTROLLERS

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

3. Control Functions:
 - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
 - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved 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.

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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 (1,000 m).
 - b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
 2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.
- M. Short Circuit Current Rating:
 1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as determined by short circuit study performed in accordance with Section 260573.
 2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.
- N. Conductor Terminations: Suitable for use with conductors to be installed.
- O. Enclosures:
 1. Comply with NEMA ICS 6.
 2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
 - a. Outdoor Locations: Type 3R or Type 4.
 3. Finish: Manufacturer's standard unless otherwise indicated.
 4. Cooling: Forced air or natural convection as determined by manufacturer.

5. Enclosure Space Heaters:
 - a. Provide in each controller enclosure installed outdoors and in unconditioned indoor spaces.
 - b. Size according to manufacturer's recommendations for worst case ambient temperature to prevent condensation.
 - c. Heater Control: Thermostat.
 - d. Heater Power Source: Provide connection to transformer factory-installed in enclosure or suitable external branch circuit as indicated or as required.

2.3 OVERCURRENT PROTECTIVE DEVICES

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

2.4 ACCESSORIES

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

1. Comply with NEMA ICS 5.
2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:

1. Size to accommodate burden of contactor coil(s) and connected auxiliary devices.
2. Include primary and secondary fuses.

2.5 SOURCE QUALITY CONTROL

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

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

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

3.3 FIELD QUALITY CONTROL

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

3.4 ADJUSTING

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

3.5 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.

3.6 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.

3.7 PROTECTION

- A. Protect installed controllers from subsequent construction operations.

3.8 MAINTENANCE

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

END OF SECTION

SECTION 232113
HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- E. ASME B31.9 - Building Services Piping 2020.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- G. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service 2019a.
- H. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts 2014 (Reapproved 2020).
- I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.
- J. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- K. ASTM B32 - Standard Specification for Solder Metal 2020.
- L. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.
- M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
- N. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications 2018.
- O. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers 1992 (Reapproved 2022).
- P. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications 2007 (Reapproved 2019).
- Q. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2023).

- R. AWWA C606 - Grooved and Shouldered Joints 2022.
- S. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 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 (110 degrees C) or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F (93 degrees C).
 - 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 (20 mm) gate valves with cap; pipe to nearest floor drain.

2. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
3. For throttling service, use plug cocks. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

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

2.2 HEATING WATER PIPING, ABOVE GRADE

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

2.3 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.

2.4 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Greater: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 Inches (50 to 100 mm): Carbon steel, adjustable, clevis.
 5. Hangers for Hot Pipe Sizes 6 Inches (150 mm) 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 (150 mm) 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 (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 11. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 12. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 13. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.5 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches (50 mm) and Less:
1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches (50 mm) and Greater:
1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
 2. Gaskets: 1/16 inch (1.6 mm) thick, preformed neoprene.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
 2. Mechanical Couplings: Comply with ASTM F1476.
 3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
 5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 7. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. Grinnell Products: www.grinnell.com/#sle.
 - c. Victaulic Company: www.victaulic.com/#sle.
- D. Dielectric Connections:
1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600-volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
 2. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.
 3. Unions:
 - a. 1/2 to 1 Inches (15 to 25 mm): Brass solder to galvanized FPT.
 - b. 1/2 to 2 Inches (15 to 50 mm): Brass solder to galvanized FPT.
 - c. 1/2 to 1 Inches (15 to 25 mm): Brass to galvanized FPT or FIP (Female Iron Pipe).
 - d. 3/4 to 1/2 Inch (20 to 15 mm) Reducer: Brass solder to galvanized FPT.
 - e. Service: 250 psi (1,723.6 kPa), minus 20 to 180 deg F (minus 28.9 to 82.2 deg F).

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and to avoid interference with use of space.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipe passing through partitions, walls, and floors.
- F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- G. Slope piping and arrange to drain at low points.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 230516.
- I. Grooved Joints:
 - 1. Install in accordance with the manufacturer's latest published installation instructions.
 - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- J. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2-inch (13 mm) space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inches (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 230719.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- M. Install valves with stems upright or horizontal, not inverted.

3.3 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 Inch (15 mm) and 3/4 inch (20 mm): Maximum span, 5 feet (1500 mm); minimum rod size, 1/4 inch (6 mm).
 - 2. 1 Inch (25 mm): Maximum span, 6 feet (1800 mm); minimum rod size, 1/4 inch (6 mm).
 - 3. 1-1/2 Inches (40 mm) and 2 Inches (50 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).

B. Hanger Spacing for Steel Piping.

1. 2-1/2 Inches (65 mm): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9 mm).
2. 3 Inches (80 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 3/8 inch (9 mm).
3. 4 Inches (100 mm): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
4. 6 Inches (150 mm): Maximum span, 17 feet (5.1 m); minimum rod size, 1/2 inch (13 mm).
5. 8 Inches (200 mm): Maximum span, 19 feet (5.8 m); minimum rod size, 5/8 inch (16 mm).

END OF SECTION

SECTION 232114
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air vents.
- B. Strainers.
- C. Pressure-temperature test plugs.
- D. Balancing valves.

1.2 RELATED REQUIREMENTS

- A. Section 232113 - Hydronic Piping.

1.3 REFERENCE STANDARDS

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 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

2.1 AIR VENTS

- A. Manual Type: Short vertical sections of 2-inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.
- B. Float Type:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- C. Washer Type:
 - 1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring-loaded ball check valve.

2.2 STRAINERS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 2. Flexicraft Industries: www.flexicraft.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
- B. Size 2 inch (50 mm) and Under:

1. Screwed brass or iron body for 175 psi (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
- C. Size 2-1/2 inch (65 mm) to 4 inch (100 mm):
 1. Provide flanged or grooved iron body for 175 psi (1200 kPa) working pressure, Y pattern with 1/16 inch (1.6 mm) or 3/64 inch (1.2 mm) stainless steel perforated screen.
- D. Size 5 inch (125 mm) and Larger:
 1. Provide flanged or grooved iron body for 175 psi (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.

2.3 PUMP CONNECTORS

- A. Manufacturers:
 1. Anvil International; AnviFlex: www.anvilintl.com/#sle.
 2. Ferguson Enterprises Inc: www.fnw.com/#sle.
 3. The Metraflex Company; Vane Flex: www.metraflex.com/#sle.
- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 1. Maximum Allowable Working Pressure: 150 psig (1030 kPa) at 120 degrees F (49 degrees C).
 2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: ____ inch (____ mm).
 - b. Lateral Movement: ____ inch (____ mm).
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 3. End Connections: Same as specified for pipe jointing.
 4. Provide pump connector with integral vanes to reduce turbulent flow.
 5. Provide necessary accessories including, but not limited to, swivel joints.

2.4 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 (93 degrees C).
- C. Application: Use extended length plugs to clear insulated piping.

2.5 BALANCING VALVES

- A. Manufacturers:
 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 2. Ferguson Enterprises Inc: www.fnw.com/#sle.
 3. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 4. ITT Bell & Gossett: www.bellgossett.com/#sle.
 5. Taco, Inc: www.taco-hvac.com/#sle.
- B. Size 2 inch (50 mm) and Smaller:
 1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
 2. Metal construction materials consist of bronze or brass.
 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- C. Size 2.5 inch (64 mm) and Larger:

1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points and as indicated.
- C. Provide manual air vents in ceiling spaces and other concealed location
- D. Provide automatic air vents in exposed locations and in mechanical rooms.
- E. Provide valved drain and hose connection on strainer blowdown connection.

END OF SECTION

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SECTION 232123
HYDRONIC PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. In-line circulators.
- B. Vertical in-line pumps.
- C. Base-mounted pumps.

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

- A. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

2.2 HVAC PUMPS - GENERAL

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

2.3 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi (860 kPa) maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Non-ferrous keyed to shaft.
- D. Bearings: Oil-lubricated bronze sleeve.
- E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.
- F. Seal: Mechanical seal, 225 degrees F (107 degrees C) maximum continuous operating temperature.

2.4 VERTICAL IN-LINE PUMPS

- A. Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi (1200 kPa) working pressure.
- B. Casing: Cast iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- E. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 250 degrees F (121 degrees C) maximum continuous operating temperature.

2.5 BASE-MOUNTED PUMPS

- A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi (860 kPa) maximum working pressure.
- B. Casing: Cast iron, or ductile iron with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed to shaft.
- D. Bearings: Oil lubricated roller or ball bearings.
- E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F. Seal: Mechanical seal, 225 degrees F (107 degrees C) maximum continuous operating temperature.
- G. Drive: Flexible coupling with coupling guard.
- H. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 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 (102 mm) 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.

END OF SECTION

SECTION 232300
REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

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

1.4 SYSTEM DESCRIPTION

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

1.5 SUBMITTALS

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

- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

1.6 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

2.1 REGULATORY REQUIREMENTS

2.2 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
- B. Pipe Supports and Anchors:
 - 1. Provide hangers and supports that comply with MSS SP-58.
 - a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3 Inches (75 mm): Cast iron hook.
 - 6. Vertical Support: Steel riser clamp.
 - 7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 - 9. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 REFRIGERANT

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

2.4 MOISTURE AND LIQUID INDICATORS

- A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F (93 degrees C) and maximum working pressure of 500 psi (3450 kPa).

2.5 VALVES

- A. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi (3450 kPa).

2.6 FILTER-DRIERS

- A. Performance:

1. Flow Capacity - Liquid Line: ____ ton (____ kW), minimum, rated in accordance with AHRI 710.
 2. Pressure Drop: 2 psi (14 kPa), maximum, when operating at full connected evaporator capacity.
 3. Design Working Pressure: 350 psi (2410 kPa), minimum.
- B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.
- C. Construction: UL listed.
1. Connections: As specified for applicable pipe type.

2.7 SOLENOID VALVES

- A. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi (3450 kPa).
- B. Coil Assembly: UL 429 UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- G. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.5.
 2. Support horizontal piping as indicated.
 3. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.

- 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- 6. Provide copper plated hangers and supports for copper piping.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Flood piping system with nitrogen when brazing.
- J. Insulate piping and equipment.
- K. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- L. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to 200 psi (1380 kPa). Perform final tests at 27 inches (92 kPa) vacuum and 200 psi (1380 kPa) using halide torch. Test to no leakage.

3.4 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch (13 mm), 5/8 inch (16 mm), and 7/8 inch (22 mm) OD: Maximum span, 5 feet (1500 mm); minimum rod size, 1/4 inch (6.3 mm).
 - 2. 1-1/8 inch (29 mm) OD: Maximum span, 6 feet (1800 mm); minimum rod size, 1/4 inch (6.3 mm).
 - 3. 1-3/8 inch (35 mm) OD: Maximum span, 7 feet (2100 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 4. 1-5/8 inch (41 mm) OD: Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 5. 2-1/8 inch (54 mm) OD: Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 6. 2-5/8 inch (67 mm) OD: Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9.5 mm).

END OF SECTION

SECTION 233100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

1.3 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 2023.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- E. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements 2018, with Editorial Revision (2020).
- F. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry 2018, with Editorial Revision (2020).
- G. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements 2017, with Editorial Revision (2020).
- H. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements 2023.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- K. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual 2012.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (Heating Systems): 2 inch wg (500 Pa) pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 2 inch wg (500 Pa) pressure class, galvanized steel.
- E. Return and Relief: 2 inch wg (___ Pa) pressure class, galvanized steel.
- F. General Exhaust: 1 inch wg (250 Pa) pressure class, galvanized steel.
- G. Transfer Air and Sound Boots: 1/2 inch wg (125 Pa) pressure class, galvanized steel.

2.2 MATERIALS

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

2.3 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.
- C. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

- D. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- E. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- F. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- G. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.4 MANUFACTURED DUCTWORK AND FITTINGS

- A. Flat Oval Ducts: Machine made from round spiral lockseam duct.
 - 1. Manufacture in accordance with SMACNA (DCS).
 - 2. Fittings: Manufacture at least two gauges heavier metal than duct.
 - 3. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- C. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- D. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.
 - 1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - 2. Pressure Rating: 10 inches wg (2.50 kPa) positive and 1.0 inches wg (250 Pa) negative.
 - 3. Maximum Velocity: 4000 fpm (20.3 m/sec).
 - 4. Temperature Range: Minus 10 degrees F to 160 degrees F (Minus 23 degrees C to 71 degrees C).
- E. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
- F. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).

2.5 CASINGS AND PLENUMS

- A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch (100 mm) high concrete curbs. At floor, rivet panels on 8 inch (200 mm) centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gauge, 0.0478 inch (1.21 mm) expanded metal mesh supported at 12 inch (300 mm) centers, turned up 12 inches (300 mm) at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Flexible Ducts: Connect to metal ducts with adhesive.

- E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- F. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with crimp in direction of air flow.
- I. Use double nuts and lock washers on threaded rod supports.
- J. Connect terminal units to supply ducts directly or with one foot (300 mm) 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 (1.5 m) maximum length of flexible duct held in place with strap or clamp.

3.2 CLEANING

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

END OF SECTION

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.
- B. NFPA 92 - Standard for Smoke Control Systems 2021, with Amendment.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 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.

1.4 SUBMITTALS

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

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

- A. Manufacturers:

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

2.2 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
1. Nailor Industries, Inc: www.nailor.com/#sle.
 2. NCA, a brand of Metal Industries Inc: www.ncamfg.com/#sle.
 3. Pottorff: www.pottorff.com/#sle.
 4. Ruskin Company: www.ruskin.com/#sle.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch (1.52 mm) 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 (3.2 by 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch (12.7 mm) actuator shaft.
- E. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- G. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.3 COMBINATION FIRE AND SMOKE DAMPERS - CORRIDOR DAMPERS

- A. Manufacturers:
1. Ruskin Company: www.ruskin.com/#sle.
 2. United Enertech: www.unitedenertech.com/#sle.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch (1.52 mm) 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 (3.2 by 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch (12.7 mm) actuator shaft.
- E. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.

- G. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.4 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.

2.5 DUCT TEST HOLES

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

2.6 FIRE DAMPERS

- A. Manufacturers:
1. Lloyd Industries, Inc: www.firedamper.com/#sle.
 2. Nailor Industries, Inc: www.nailor.com/#sle.
 3. Ruskin Company: www.ruskin.com/#sle.
 4. United Enertech: www.unitedenertech.com/#sle.
 5. Ward Industries, a brand of Hart and Cooley, Inc: www.wardind.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Horizontal Dampers: Galvanized steel, 22 gauge, 0.0299 inch (0.76 mm) frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- D. Fusible Links: UL 33, separate at 160 degrees F (71 degrees C) with adjustable link straps for combination fire/balancing dampers.

2.7 FLEXIBLE DUCT CONNECTORS

- A. Manufacturers:
1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
 2. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 3. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Flexible Duct Connections: Fabric crimped into metal edging strip.
- D. Maximum Installed Length: 14 inch (356 mm).

2.8 VOLUME CONTROL DAMPERS

- A. Manufacturers:
1. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 2. Nailor Industries, Inc: www.nailor.com/#sle.
 3. Ruskin Company: www.ruskin.com/#sle.
 4. United Enertech: www.unitedenertech.com/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.

- C. Splitter Dampers:
- D. Single Blade Dampers:
 - 1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
 - 2. Blade: 24 gauge, 0.0239 inch (0.61 mm), minimum.
- E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch (200 by 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
 - 1. Blade: 18 gauge, 0.0478 inch (1.21 mm), minimum.
- F. End Bearings: Except in round ducts 12 inches (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 233100 for duct construction and pressure class.
- B. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 by 8 inch (200 by 200 mm) size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch (100 by 100 mm) for balancing dampers only. Review locations prior to fabrication.
- C. Provide duct test holes where indicated and required for testing and balancing purposes.
- D. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- I. Use splitter dampers only where indicated.
- J. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 233423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof exhausters.

1.2 RELATED REQUIREMENTS

- A. Section 233100 - HVAC Ducts and Casings.
- B. Section 233300 - Air Duct Accessories: Backdraft dampers.

1.3 REFERENCE STANDARDS

- A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
- B. AMCA 99 - Standards Handbook 2016.
- C. AMCA 204 - Balance Quality and Vibration Levels for Fans 2020.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
- E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.

1.4 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.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Fan Belts: One set for each individual fan.

1.6 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 POWER VENTILATORS - GENERAL

- A. Manufacturers:
 - 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
- B. Static and Dynamically Balanced: Comply with AMCA 204.
- C. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.
- D. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.
- E. Fabrication: Comply with AMCA 99.

- F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.2 ROOF EXHAUSTERS

- A. Manufacturers:
1. Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
 2. Greenheck Fan Corporation: www.greenheck.com/#sle.
 3. Twin City Fan & Blower; BCRD: www.tcf.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch (13 mm) mesh, 0.62 inch (1.6 mm) thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- C. Roof Curb: 16 inch (400 mm) high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- D. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- E. Backdraft Damper: Aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

PART 3 EXECUTION

3.1 INSTALLATION

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

END OF SECTION

SECTION 233700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE STANDARDS

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

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

2.2 RECTANGULAR CEILING DIFFUSERS

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

2.3 DUCT-MOUNTED SUPPLY AND RETURN REGISTERS/LOUVERS

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

2.4 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 1/2 inch (_____ mm) maximum spacing, with blades set at 45 degrees, vertical face.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.
- C. Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Color: As indicated.
- E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.5 GRAVITY VENTILATORS

- A. Hood Intake and Relief Gravity Ventilator:
 - 1. Manufacturers:
 - a. American Coolair Corporation: www.coolair.com/#sle.
 - b. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - c. Loren Cook Company: www.lorencook.com/#sle.
 - 2. General:
 - a. Low silhouette for intake applications with natural gravity or negative pressure system(s).
 - b. Performance ratings and factory testing to be in accordance with AMCA 511 and AMCA 550.
 - c. Suitable for non-ducted applications.
 - d. Equipment to bear permanently affixed manufacturer's nameplate listing model and serial number.
 - 3. Hood and Base:
 - a. Material: Aluminum.
 - b. Hood Construction: Precision formed, arched panels with interlocking seams.
 - c. Vertical End Panels: Fully locked into hood end panels.
 - d. Curb Cap: Pre-punched mounting holes for installation.
 - 4. Birdscreen:
 - a. Fabricate in accordance with ASTM B221 (ASTM B221M).
 - b. Construction: 1/2 inch (12.7 mm) Galvanized mesh.
 - c. Horizontally mounted across hood intake area.

PART 3 EXECUTION

3.1 INSTALLATION

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

- E. Paint ductwork visible behind air outlets and inlets matte black, see Section 099123.

END OF SECTION

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SECTION 236313
AIR COOLED REFRIGERANT CONDENSERS**<<<< UPDATE NOTES****PART 1 GENERAL****2.1 SECTION INCLUDES**

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

2.2 RELATED REQUIREMENTS

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

2.3 REFERENCE STANDARDS

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

2.4 SUBMITTALS

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

2.5 QUALITY ASSURANCE

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

PART 2 PRODUCTS**3.1 MANUFACTURERS**

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

3.2 PERFORMANCE REQUIREMENTS**3.3 MANUFACTURED UNITS**

- A. Provide packaged, factory assembled, pre-wired unit, suitable for outdoor use consisting of casing, condensing coil and fans, integral sub-cooling coil liquid accumulator.

- B. Construction and Ratings: In accordance with AHRI 210/240 and UL 207. Testing shall be in accordance with ASHRAE Std 20.
- C. Performance Ratings: Energy Efficient Rating (EER)/Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1 I-P, in combination with compressor units.

3.4 CASING

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

3.5 CONDENSER COILS

- A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig (2900 kPa), and vacuum dehydrate. Seal with holding charge of nitrogen.

3.6 FANS AND MOTORS

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

3.7 CONTROLS

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

PART 3 EXECUTION

4.1 INSTALLATION

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

END OF SECTION

SECTION 237223
PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 GENERAL**1.1 SECTION INCLUDES**

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

1.2 RELATED REQUIREMENTS

- A. Section 077200 - Roof Accessories: Roof curb.

1.3 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating 2018.
- B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating 2012, with Editorial Revision (2015).
- C. AHRI 1060 (I-P) - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment 2018.
- D. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Addendum (2022).
- E. ASHRAE Std 84 - Method of Testing Air-to-Air Heat/Energy Exchangers 2020, with Errata (2021).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- 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 2024.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store in manufacturer's unopened packaging.

1.6 WARRANTY

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

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Energy Recovery Ventilators:
 - 1. RenewAire: www.renewaire.com/#sle.
 - 2. Ruskin Company: www.ruskin.com/#sle.
 - 3. Semco Inc.: www.semcohv.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Basis of Design: RenewAire: www.renewaire.com/#sle.

2.2 ENERGY RECOVERY UNITS

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

2.3 CASING

- A. Wall, Floor, and Roof Panels:
 - 1. Panels: Removable.
 - 2. Construction: 1 inch (25 mm) thick, double wall box construction, with formed edges of exterior wall overlapping formed edges of interior wall.
 - 3. Aluminum is standard. Factory-painted aluminized steel is an economic alternative when the higher corrosion resistance of aluminum is not required.
 - 4. Exterior Wall: Galvanized steel sheet.
 - a. 0.040 inches (1 mm) thick aluminum.
 - 5. Interior Wall: Galvanized sheet metal.
 - a. 22 gauge, 0.0299 inch (0.76 mm) galvanized sheet metal.
 - 6. Insulation:
 - a. 1/2 inch (13 mm) insulated fiberglass.
 - b. Panel Cores: Mineral wool board.
 - c. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.
 - d. Smoke Developed Index (SDI): 50, maximum, when tested in accordance with ASTM E84 or UL 723.
 - 7. Roof Panel: Weatherproof.
 - 8. Coating: Polyurethane enamel.
- B. Access Panels: Provide access to components through a large, tightly sealed and easily removable panel.
- C. Doors:
 - 1. Construct doors of same construction and thickness as wall panels.

2.4 FANS

- A. Provide separate fans for exhaust and supply blowers.
- B. Fans:
 - 1. Individually driven with a dedicated motor.

- C. Housings: 12 gauge, 0.1046 inch (2.66 mm) aluminized steel with plenums integral to general housing and constructed to Class 1 fan standards.
- D. Motors:
 - 1. Motors: Open drip proof.
 - 2. Efficiency: High.
 - 3. Speed: Single.
 - 4. Control: Constant Speed.
 - 5. Fan Motor: UL listed and labeled.
- E. Drives:
 - 1. Fans: Belt driven.
 - 2. Horsepower: 7.5 HP (5.2 kW).
 - 3. Service Factor: 1.2.

2.5 TOTAL ENERGY WHEEL

- A. Wheel: Transfer heat and humidity from one air stream to the other with minimum carryover of the exhaust air into the supply air stream.
- B. Energy Wheel Media: Cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery.
- C. Sensible Recovery Efficiency: AS SCHEDULED..
- D. Latent Recovery Efficiency: AS SCHEDULED..
- E. Wheel Effectiveness: Rated in accordance with ASHRAE Std 84 and AHRI 1060 (I-P).
- F. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.
- G. Smoke Developed Index (SDI): 50 or less, when tested in accordance with ASTM E84 or UL 723.
- H. Energy Recovery Wheel Media Face:
 - 1. Comply with NFPA 90A.
- I. Rotor:
 - 1. Type: Non-segmented hygroscopic aluminum wheel.
 - 2. Rotor Matrix: Corrosion resistant aluminum alloy composed of alternating corrugated and flat, continuously wound layers of uniform widths.
- J. Desiccant:
 - 1. Type: 3A.
- K. Drive:
 - 1. Drive: Tensioned drive with full perimeter link style belt.

2.6 FILTERS

- A. Exhaust and Fresh Air Streams: MERV 8 filters constructed to meet ASHRAE Std 52.2.

2.7 DAMPERS

- A. Exhaust Back-Draft Damper: Factory installed, galvanized steel.
 - 1. High performance, backdraft dampers suitable for application in HVAC systems with velocities to 3000 feet per minute (914 m/min).
 - 2. Louvers, Dampers, and Shutters: AMCA 500-D and AMCA 500-L.
 - 3. Damper Capacity: Demonstrate damper capacity to withstand HVAC system operating conditions.
 - 4. Fabrication:
 - a. Frame: 20 gauge, 0.0359 inch (0.91 mm), 3 inch (76 mm) roll formed galvanized steel channel with rear flange, prepunched mounting holes, and welded corner clips for maximum rigidity.

- b. Blades:
 - 1) Style: Single-piece, overlap frame.
 - 2) Material: Roll formed 28 gauge, 0.0149 inch (0.38 mm) galvanized steel.
 - 3) Width: Maximum 6 inches (152 mm).
- B. Return Air Damper:
 - 1. Factory installed, adjustable volume control, opposed blade damper for regulating airflow, based on external static pressure.
 - 2. Return Air Damper: Structural hat channels, reinforced at corners.
 - 3. Roll-formed Frames: Structurally superior to 13 gauge, 0.0897 inch (2.28 mm) U-channel frames.
 - 4. Blades: Single skin, 16 gauge, 0.0598 inch (1.52 mm).
- C. Motorized Dampers: Provide motorized dampers at outside air inlet, exhaust air outlet, and supply air outlet.
 - 1. Type: Motorized two position parallel blade damper with blade seals.
 - 2. Motorized Damper: Roll-formed structural hat channels, reinforced at the corners.
 - 3. Blades: Single skin, 16 gauge, 0.0598 inch (1.52 mm).
- D. Motorized Louvers:
 - 1. Type: Motorized two position parallel blade louver with drainable blades, blade seals, and jamb seals
 - 2. Adjustable louver:
 - a. Fabrication: Mullion style.
 - 1) Frame:
 - (a) Material: Extruded aluminum, Alloy 6063-T5.
 - 2) Blades:
 - (a) Style: Horizontal, adjustable, drainable.
 - (b) Material: Formed aluminum, Alloy 6063-T5.

2.8 ROOF CURBS

- A. Curbs: Provide full perimeter roof curb fabricated from 10 gauge, 0.1345 inch (3.42 mm) aluminized steel.
 - 1. Curbs: Knock-down type.

2.9 POWER AND CONTROLS

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

2.10 SERVICE ACCESSORIES

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

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 SYSTEM STARTUP

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

3.4 CLEANING

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

END OF SECTION

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SECTION 237413**PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Packaged roof top unit.
- B. Unit controls.
- C. Remote panel.
- D. Roof mounting curb and base.

1.2 RELATED REQUIREMENTS

- A. Section 077200 - Roof Accessories: Placement and installation of factory fabricated roof mounting curbs.
- B. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- C. Section 230913 - Instrumentation and Control Devices for HVAC: Control components, time clocks.
- D. Section 260583 - Wiring Connections: Installation and wiring of thermostats and other controls components; wiring from unit terminal strip to remote panel.

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.

1.4 SUBMITTALS

- A. 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.
- B. 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.
- C. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Filters: One set for each unit.

1.5 QUALITY ASSURANCE

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

1.6 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.

1.7 WARRANTY

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

PART 2 PRODUCTS**2.1 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.

2.2 MANUFACTURED UNITS

- A. General: Roof mounted units having gas burner and electric refrigeration.
- B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, heat exchanger and burner, heat recovery coil, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

2.3 FABRICATION

- A. Cabinet: Steel with baked enamel finish, including access panels with screwdriver operated flush cam type fasteners. Structural members shall be minimum 18 gauge, 0.0478 inch (1.21 mm), with access doors or panels of minimum 20 gauge, 0.0359 inch (0.91 mm).
- B. Heat Exchangers: Aluminized steel, of welded construction.
- C. Supply and Return Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley, and rubber isolated hinge mounted high efficiency motor or direct drive as indicated. Refer to Section 220548.
- D. Air Filters:
 - 1. 2 inch (50 mm) thick glass fiber disposable media in metal frames.
- E. Roof Mounting Curb: 14 inches (350 mm) high galvanized steel, channel frame with gaskets, nailer strips.

2.4 ELECTRIC HEATING COIL

- A. Finned tube heating elements easily accessible with automatic reset thermal cut-out, built-in magnetic contactors, galvanized steel frame, control circuit transformer and fuse, manual reset thermal cut-out, airflow proving device, toggle switch (pilot duty), load fuses.
- B. Controls: Start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.

2.5 EVAPORATOR COIL

- A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
- B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons (21 kw) capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons (26 kw) cooling capacity and larger.

2.6 COMPRESSOR

- A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.

2.7 CONDENSER COIL

- A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.

- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.

2.8 MIXED AIR CASING

- A. Gaskets: Provide tight fitting dampers with edge gaskets.

2.9 OPERATING CONTROLS

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

2.10 OPERATING CONTROLS - SINGLE ZONE UNITS

- A. Electric solid state microcomputer based room thermostat, located as indicated in service area with remote sensor located as indicated.

2.11 OPERATING CONTROLS - VARIABLE VOLUME UNITS

- A. Temperature transmitter located in supply air shall signal electronic logic panel to control mixing dampers and cooling in sequence. Mixing section shall operate as first stage of cooling and revert to minimum outside air above approximately 75 degrees F (24 degrees C) as determined by enthalpy of return and outdoor air.
- B. Control cooling by cycling compressors, cylinder unloading, and hot gas bypass.

2.12 HEAT RECOVERY COIL

- A. Provide copper tube aluminum fin coil assembly with multiple circuits arranged to provide heat recovery.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

END OF SECTION

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SECTION 238126.13**SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Air-source heat pumps.
- B. Air cooled condensing units.
- C. Indoor air handling (fan and coil) units for ducted systems.
- D. Indoor air handling (fan and coil) units for ductless systems.
- E. Controls.

1.2 RELATED REQUIREMENTS

- A. Section 233100 - HVAC Ducts and Casings.
- B. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units 2004.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2022, with Errata (2023).
- D. ASHRAE Std 23.1 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant 2019.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.
- F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.
- G. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Design Data: Indicate refrigerant pipe sizing.
- D. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

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

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturers warranty for solid state ignition modules.
- C. Provide five year manufacturers warranty for heat exchangers.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Fujitsu - Basis of Design.

2.2 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator; auxiliary electric heat.
 2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B. Performance Requirements: See Drawings for additional requirements.
- C. Electrical Characteristics:
1. _____ kW.
 2. _____ volts, single phase, 60 Hz.
 3. _____ amperes maximum fuse size.
 4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 260583.

2.3 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 2. Manufacturer: System manufacturer.

2.4 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
1. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
- B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
- C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
1. Provide thermostatic expansion valves.
- D. Operating Controls:
1. Control by room thermostat to maintain room temperature setting.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.
- C. Verify that proper fuel supply is available for connection.

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Small-Capacity Split-System Air
Conditioners

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3.2 INSTALLATION

- A. Install in accordance with NFPA 90A and NFPA 90B.
- B. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION

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SECTION 238200
CONVECTION HEATING AND COOLING UNITS**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Hydronic or steam finned tube radiation.
- B. Duct-mounted coils.

1.2 RELATED REQUIREMENTS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment-CPL.
- B. Section 230719 - HVAC Piping Insulation-CPL.
- C. Section 230913 - Instrumentation and Control Devices for HVAC.
- D. Section 230993 - Sequence of Operations for HVAC Controls.
- E. Section 232113 - Hydronic Piping.
- F. Section 232114 - Hydronic Specialties.
- G. Section 232300 - Refrigerant Piping.
- H. Section 233100 - HVAC Ducts and Casings.

1.3 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Current Edition.
- B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
 - 3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 4. Indicate mechanical and electrical service locations and requirements.
- D. Selection Samples: For each finish product specified, color chart representing manufacturer's full range of available colors.
- E. Verification Samples: For each finish product specified, color chip representing actual product in color and texture.
- F. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
- G. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- I. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements for additional provisions.
2. Extra Filters: Two sets of each type and size.

1.5 QUALITY ASSURANCE

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

1.6 WARRANTY

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

PART 2 PRODUCTS

2.1 HYDRONIC FINNED TUBE RADIATION

- A. Manufacturers:
 1. Modine Manufacturing Company: www.modineHVAC.com/#sle.
 2. Slant/Fin Corporation: www.slantfin.com/#sle.
 3. Zehnder Rittling: www.rittling.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Required Directory Listing: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
- C. Heating Elements: 1 inch (25 mm) ID seamless copper tubing, mechanically expanded into evenly spaced aluminum fins sized as noted on drawings (), suitable for soldered fittings.
- D. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- E. Enclosures: 18 gauge, 0.0478 inch (1.21 mm) sheet steel up to 18 inches (450 mm) in height, 16 gauge, 0.0598 inch (1.52 mm) sheet steel over 18 inches (450 mm) in height or aluminum as detailed, with easily jointed components for wall to wall installation.
 1. Support rigidly, on wall or floor mounted brackets.
- F. Finish: Factory applied baked primer coat.
- G. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch (150 by 175 mm) minimum size, integral with cabinet.

2.2 DUCT-MOUNTED COILS

- A. Water Coils:
 1. Manufacturers:
 - a. Aerofin Corporation: www.aerofin.com/#sle.
 - b. Trane Technologies, PLC: www.trane.com/#sle.
 - c. USA Coil & Air: www.usacoil.com/#sle.
 - d. Capital coil.
 2. Coils rated and tested in accordance with AHRI 410.
 3. Tubes: Material to consist of seamless copper or brass, 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:

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Finned Tube Radiation:
 - 1. Center elements under window with elements of equal length centered under each window for multiple windows.
 - 2. Align cabinet joints with window mullions.
- C. 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.
- D. Units with Cooling Coils: Connect drain pan to condensate drain.
- E. Air Coils:
 - 1. Install in ducts and casings in accordance with SMACNA (DCS).
 - a. Support coil sections independent of piping on steel channel or double angle frames and secure to casing.
 - b. Arrange supports to avoid piercing drain pans.
 - c. Provide airtight seals between coil and casing or duct.
 - d. See Section 233100.
 - 2. Coil Safeguards:
 - a. Protect coils to prevent damage to flanges and fins.
 - b. Comb out damaged fins.
 - 3. Install all coils level except cleanable coils with 1:50 pitch.
 - 4. Cooling Coils:
 - a. Cooling Condensate Drain Pan and Drain Connection:
 - 1) Pipe drains individually to location as indicated on drawings with water seal trap.
 - 5. Refrigerant Coils:
 - a. See Section 232300.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections
 - 1. Leak test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- B. Units will considered defective if they do not pass test and inspections.
- C. Prepare test and inspection reports.

3.4 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.

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Convection Heating and Cooling
Units

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3.5 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for closeout submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.

3.6 PROTECTION

- A. Provide finished cabinet units with protective covers during the balance of construction.

END OF SECTION

SECTION 238216
AIR COILS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water heating coils.
- B. Water cooling coils.
- C. Electric coils.

1.2 RELATED REQUIREMENTS

- A. Section 220719 - Plumbing Piping Insulation.
- B. Section 230719 - HVAC Piping Insulation-CPL.
- C. Section 232114 - Hydronic Specialties.
- D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

1.5 QUALITY ASSURANCE

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

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for _____.

PART 2 PRODUCTS

2.1 WATER HEATING COILS

- A. Tubes: 5/8 inch (16 mm) OD seamless copper or brass arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
- B. Casing: Die formed channel frame of 16 gauge, 0.0598 inch (1.52 mm) galvanized steel with mounting holes on 3 inch (75 mm) centers. Provide tube supports for coils longer than 36 inches (900 mm).
- C. Headers: Cast iron with tubes expanded into header.
- D. Testing: Air test under water to 200 psi (1380 kPa) for working pressure of 200 psi (1380 kPa) and 220 degrees F (104 degrees C).

2.2 ELECTRIC COILS

- A. Manufacturers:
 - 1. INDEECO (Industrial Engineering and Equipment Company): www.indeeco.com/#sle.

- B. Assembly: UL listed and labelled, with terminal control box and hinged cover, splice box, coil, casing, and controls.
- C. Coil: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material.
- D. Casing: Die formed channel frame of 16 gauge, 0.0598 inch (1.52 mm) galvanized steel with 3/8 inch (9.5 mm) mounting holes on 3 inch (75 mm) centers. Provide tube supports for coils longer than 36 inches (900 mm).
- E. Controls: Automatic reset thermal cut-out, built-in magnetic contactors, control circuit transformer and fuse, manual reset thermal cut-out, air flow proving device, fused disconnect, load fuses.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Install in ducts and casings in accordance with SMACNA (DCS).
- C. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Ensure water coils are drainable and provide drain connection at low points.
- D. Electric Duct Coils: Wire in accordance with NFPA 70. Refer to Section 260583.

END OF SECTION

**SECTION 238236
FINNED-TUBE RADIATION HEATERS****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes hydronicsteam, finned-tube radiation heaters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and 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 details and dimensions of custom-fabricated enclosures.
 - 4. Indicate location and size of each field connection.
 - 5. Indicate location and arrangement of piping valves and specialties.
 - 6. Indicate location and arrangement of integral controls.
 - 7. Include enclosure joints, corner pieces, access doors, and other accessories.
 - 8. Include diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.
- E. Color Samples for Verification: For each type of exposed finish.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.
 - 2. Method of attaching finned-tube radiation heaters to building structure.
 - 3. Penetrations of fire-rated wall and floor assemblies.
- B. Field quality-control reports.

PART 2 PRODUCTS**2.1 HOT-WATER FINNED-TUBE RADIATION HEATERS**

- A. Manufacturers
 - 1. Slant/Fin
 - 2. Sterling – Basis of design
 - 3. Vulcan
- B. Performance Ratings: Rate finned-tube radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
- C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One end of tube shall be belled.

- D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
- E. Front Panel: Minimum 0.0428-inch-thick steel.
- F. Wall-Mounted Back Panel: Minimum 0.0329-inch-thick steel, full height, with full-length channel support for front panel without exposed fasteners.
- G. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
- H. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
- I. Damper: Knob-operated internal damper at enclosure outlet.
- J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.
- K. Enclosure Style: Sloped top.
- L. Top Outlet Grille: Punched louver; painted to match enclosure; pencil-proof bar spacing..
- M. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FINNED-TUBE RADIATION HEATER INSTALLATION

- A. Install units level and plumb.
- B. Install enclosure continuously around corners, using outside and inside corner fittings.
- C. Join sections with splice plates and filler pieces to provide continuous enclosure.
- D. Install access doors for access to valves.
- E. Install enclosure continuously from wall to wall.
- F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.
- G. Install valves within reach of access door provided in enclosure.
- H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.
- I. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot-water finned-tube radiation heaters and components to piping according to Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
 - 1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.
- C. Install control valves as required by Section 230923.11 "Control Valves."
- D. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 238236

END OF SECTION

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**SECTION 260505
SELECTIVE DEMOLITION FOR ELECTRICAL****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Electrical demolition.

1.2 RELATED REQUIREMENTS

- A. Section 017000 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS**2.1 MATERIALS AND EQUIPMENT**

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION**3.1 EXAMINATION**

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

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 48 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
 - 3. Make notifications at least 48 hours in advance.
 - 4. Make temporary connections to maintain service in areas adjacent to work area.
- F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner at least 48 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.

- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

- A. See Section 017419 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

SECTION 260519**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Wiring connectors.
- D. Electrical tape.
- E. Heat shrink tubing.
- F. Wire pulling lubricant.
- G. Cable ties.
- H. Firestop sleeves.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 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 267 - Outline of Investigation for Wire-Pulling Compounds Current Edition, Including All Revisions.

- O. UL 486A-486B - Wire Connectors Current Edition, Including All Revisions.
- P. UL 486C - Splicing Wire Connectors Current Edition, Including All Revisions.
- Q. UL 486D - Sealed Wire Connector Systems Current Edition, Including All Revisions.
- R. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape Current Edition, Including All Revisions.
- S. UL 1569 - Metal-Clad Cables Current Edition, Including All Revisions.

1.4 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.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- D. Field Quality Control Test Reports.
- E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (-10 degrees C), 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

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:

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- a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
- b. Where concealed in hollow stud walls and above accessible ceilings for branch circuits up to 20 A.
2. In addition to other applicable restrictions, may not be used:
 - a. Where exposed to damage.
 - b. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 3. Tinned Copper Conductors: Comply with ASTM B33.
- H. Minimum Conductor Size:
 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 100 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
- I. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- J. Conductor Color Coding:
 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 3. Color Code:
 - a. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - b. Equipment Ground, All Systems: Green.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 1. Copper Building Wire:

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- 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.

2.4 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.

2.5 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.

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2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
 6. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- G. Push-in Wire Connectors: Rated 600 V, 221 degrees F (105 degrees C).
1. Manufacturers:
 - a. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - b. NSI Industries LLC: www.nsiindustries.com/#sle.
 - c. Wago Corporation: www.wago.us/#sle.
- H. Mechanical Connectors: Provide bolted type.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.6 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 (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
 - 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
 - 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.
 - 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).
 - 6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil (2.3 mm).
- 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.
- C. Wire Pulling Lubricant:
- 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.
 - 2. Listed and labeled as complying with UL 267.
 - 3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 - 4. Suitable for use at installation temperature.
 - 5. Products:
 - a. American Polywater Corporation; Polywater J Cable Pulling Lubricant: www.polywater.com/#sle.
 - b. American Polywater Corporation; Polywater LZ Cable Pulling Lubricant: www.polywater.com/#sle.
- D. 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.
- E. 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.
- F. 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**3.1 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.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 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 (3.0 m) of location indicated.
 - 5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 - 6. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install metal-clad cable (Type MC) in accordance with NECA 120.
- E. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
- H. Terminate cables using suitable fittings.
 - 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- I. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

- J. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- K. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- L. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- M. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
- N. Insulate ends of spare conductors using vinyl insulating electrical tape.
- O. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- P. Identify conductors and cables in accordance with Section 260553.
- Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL**1.1 SECTION INCLUDES**

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.3 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. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 467 - Grounding and Bonding Equipment Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS**2.1 GROUNDING AND BONDING REQUIREMENTS**

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- F. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 2. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- G. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:
1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
4. Manufacturers - Mechanical and Compression Connectors:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Harger Lightning & Grounding: www.harger.com/#sle.
 - c. nVent ERICO: www.nvent.com/#sle.
 - d. Thomas & Betts Corporation: www.tnb.com/#sle.
5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. nVent ERICO; Cadweld: www.nvent.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Make grounding and bonding connections using specified connectors.
 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

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SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL**1.1 SECTION INCLUDES**

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- C. Section 260533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- D. Section 262513 - Low-Voltage Busways: Additional support and attachment requirements for busway.
- E. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- F. Section 265600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.
- D. MFMA-4 - Metal Framing Standards Publication 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

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

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.6 QUALITY ASSURANCE

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
 - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. nVent; Caddy: www.nvent.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
 - 2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 3. Conduit Clamps: Bolted type unless otherwise indicated.
 - 4. Products:
 - a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
 - b. Gripple, Inc; Fast Trak: www.gripple.com/#sle.
 - c. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
 - d. Gripple, Inc; Low Profile Bracket Kits: www.gripple.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. nVent; Caddy: www.nvent.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
- D. Metal Channel/Strut Framing Systems:
1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - c. Custom Strut and Roll Forming, LLC: www.customstrut.com/#sle.
 - d. Eaton Corporation: www.eaton.com/#sle.
 - e. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
 - g. Source Limitations: Furnish channel/strut and associated fittings, accessories, and hardware produced by single manufacturer.
 2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 3. Comply with MFMA-4.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch (13 mm) diameter.
 - b. Busway Supports: 1/2-inch (13 mm) diameter.
 - c. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch (6 mm) diameter.
 - d. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch (10 mm) diameter.
 - e. Trapeze Support for Multiple Conduits: 3/8-inch (10 mm) diameter.
 - f. Outlet Boxes: 1/4-inch (6 mm) diameter.
 - g. Luminaires: 1/4-inch (6 mm) diameter.
- F. Anchors and Fasteners:
1. Manufacturers - Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
 4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 6. Hollow Masonry: Use toggle bolts.
 7. Hollow Stud Walls: Use toggle bolts.

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8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
9. Sheet Metal: Use sheet metal screws.
10. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.

PART 3 EXECUTION**3.1 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.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Conduit Support and Attachment: See Section 260533.13 for additional requirements.
- I. Busway Support and Attachment: See Section 262513 for additional requirements.
- J. Interior Luminaire Support and Attachment: See Section 265100 for additional requirements.
- K. Exterior Luminaire Support and Attachment: See Section 265600 for additional requirements.
- L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- M. Secure fasteners in accordance with manufacturer's recommended torque settings.
- N. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.

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- 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

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SECTION 260533.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Stainless steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Galvanized steel electrical metallic tubing (EMT).
- F. Stainless steel electrical metallic tubing (EMT).

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- D. Section 260529 - Hangers and Supports for Electrical Systems.
- E. Section 260533.16 - Boxes for Electrical Systems.
- F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 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 2015.
- D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT) 2020.
- E. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 1 - Flexible Metal Conduit Current Edition, Including All Revisions.
- H. UL 6 - Electrical Rigid Metal Conduit-Steel Current Edition, Including All Revisions.
- I. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel Current Edition, Including All Revisions.
- J. UL 360 - Liquid-Tight Flexible Metal Conduit Current Edition, Including All Revisions.
- K. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.
- L. UL 746C - Polymeric Materials – Use in Electrical Equipment Evaluations Current Edition, Including All Revisions.
- M. UL 797 - Electrical Metallic Tubing-Steel Current Edition, Including All Revisions.
- N. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel Current Edition, Including All Revisions.
- O. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
 - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.6 QUALITY ASSURANCE

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Within Hollow Stud Walls: Use galvanized steel electrical metallic tubing (EMT).
- D. Concealed Above Accessible Ceilings: Use galvanized steel electrical metallic tubing (EMT).
- E. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC).
- F. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).
- G. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- H. Exposed, Interior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).
 - 1. Locations subject to severe physical damage include, but are not limited to:
 - a. High traffic industrial and warehouse areas where exposed below 8 feet (2.4 m), except within electrical and communication rooms or closets.
 - b. Where exposed below 20 feet (6.1 m) in industrial manufacturing areas.

- I. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).
- J. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Fittings for Grounding and Bonding: See Section 260526 for additional requirements.
- D. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 3/4-inch (21 mm) trade size.
 - 2. Branch Circuit Homeruns: 3/4-inch (21 mm) trade size.
 - 3. Flexible Connections to Luminaires: 3/8-inch (12 mm) trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - 2. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
 - 3. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

- B. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.
 - 1. Material: Type 304 or 316 stainless steel.
- C. Fittings:
 - 1. Manufacturers:
 - a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - b. Eaton: www.eaton.com/#sle.
 - c. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
 - d. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
 - 3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.5 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.

2.7 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 2. Nucor Tubular Products: www.nucortubular/#sle.
 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. _____.
 - f. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 4. Connectors and Couplings: Use compression/gland type.
 - a. Do not use indenter type connectors and couplings.

2.8 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 2. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.
- C. Fittings:
 1. Manufacturers:
 - a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
 4. Connectors and Couplings: Use compression/gland type.

2.9 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch (0.51 mm).
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

- E. Adhesive for HDPE and RTRC Conduit:
 - 1. Specifically designed for bonding dissimilar materials in lieu of transition fittings, including but not limited to polyethylene, fiberglass, PVC, aluminum, and steel; UL 746C recognized.
 - 2. Approved by adhesive manufacturer for use with materials to be joined.
- F. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf (5.6 kN).
- G. Sealing Systems for Concrete Penetrations:
 - 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 - 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
 - 3. Products:
 - a. American Polywater Corporation; PZVR Cement-Coated Concrete Wall Sleeves: www.polywater-haufftechnik.com/#sle.
 - b. American Polywater Corporation; PHSD Mechanical Seals: www.polywater-haufftechnik.com/#sle.
 - c. American Polywater Corporation; PHSI 150 Varia Double Wall Inserts: www.polywater-haufftechnik.com/#sle.
 - d. American Polywater Corporation; PGKD Modular Seals: www.polywater-haufftechnik.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- H. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
 - 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- I. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
 - 1. Products:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- J. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.

- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - 5. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 6. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
 - 7. Arrange conduit to provide no more than 150 feet (46 m) between pull points.
 - 8. Route conduits above water and drain piping where possible.
 - 9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 10. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.
- E. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 - 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 - 5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 - 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 - 7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
 - 8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
 - 9. Use of spring steel conduit clips for support of conduits is not permitted.
 - a. Support of electrical metallic tubing (EMT) up to 1-inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
 - 10. Use of wire for support of conduits is not permitted.
 - 11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.
- F. Connections and Terminations:
 - 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 - 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 - 3. Use suitable adapters where required to transition from one type of conduit to another.
 - 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.

5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
 7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
 8. Secure joints and connections to provide mechanical strength and electrical continuity.
- G. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 8. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.
- H. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where conduits are subject to earth movement by settlement or frost.
- I. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- J. Provide grounding and bonding; see Section 260526.
- K. Identify conduits; see Section 260553.
- 3.3 FIELD QUALITY CONTROL**
- A. See Section 014000 - Quality Requirements for additional requirements.
 - B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
 - C. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.5 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

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SECTION 260533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.

1.2 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.

1.3 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 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports 2013 (Reaffirmed 2020).
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.
- K. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.

1.4 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.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements, for additional provisions.
 2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 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 (1,650 cu cm), Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.

2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 4. Use suitable concrete type boxes where flush-mounted in concrete.
 5. Use suitable masonry type boxes where flush-mounted in masonry walls.
 6. Use raised covers suitable for the type of wall construction and device configuration where required.
 7. Use shallow boxes where required by the type of wall construction.
 8. Do not use "through-wall" boxes designed for access from both sides of wall.
 9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 13. Wall Plates: Comply with Section 262726.
 14. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
 - c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet (0.56 sq m) and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 5. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
 2. Unless dimensioned, box locations indicated are approximate.
 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 (150 mm) horizontal separation unless otherwise indicated.
 8. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.13.
 9. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
 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.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6 mm) 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 (3 mm) at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- O. Close unused box openings.
- P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- Q. Provide grounding and bonding in accordance with Section 260526.
- R. Identify boxes in accordance with Section 260553.

3.3 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

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SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 099113 - Exterior Painting.
- B. Section 099123 - Interior Painting.
- C. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 262726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- E. Section 271000 - Structured Cabling: Identification for communications cabling and devices.

1.3 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.

1.4 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.

1.5 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.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS**2.1 IDENTIFICATION REQUIREMENTS**

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.

B. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
2. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
3. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
7. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
8. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.

C. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

D. Identification for Raceways:

1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet (6.1 m).
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 (6.1 m).
 - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches (76 mm) wide.
 - 1) Field-Painting: Comply with Section 099123 and 099113.
 - 2) Vinyl Color Coding Electrical Tape: Comply with Section 260519.

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3. Use identification labels or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
- E. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 099123 and 099113 per the same color code used for raceways.
 3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- F. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 271000.
 2. Wiring Device and Wallplate Finishes: Comply with Section 262726.
 3. Factory Pre-Marked Wallplates: Comply with Section 262726.
 4. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
 5. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
 6. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
- G. Identification for Luminaires:
1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.2 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 (1.6 mm); engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch (3 mm) when any dimension is greater than 4 inches (100 mm).
 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.

6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
2. Legend:
 - a. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
 - a. Equipment Designation: 1/2 inch (13 mm).
5. Color:
 - a. Normal Power System: White text on black background.
 - 1) 208Y/120 V, 3 Phase Equipment: White text on Black background.
 - b. Emergency Power System: White text on red background.

D. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
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 mm).
5. Color: Black text on clear background.

E. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch (5 mm).
5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:

1. Brady Corporation: www.bradyid.com/#sle.
2. HellermannTyton: www.hellermanntyton.com/#sle.
3. Panduit Corp: www.panduit.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

- F. Minimum Text Height: 1/8 inch (3 mm).
- G. Color: Black text on white background unless otherwise indicated.

2.4 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 (29 by 110 mm).
 - 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 (29 by 110 mm).
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches (13 by 57 mm).
- E. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
- F. Color: Black text on orange background unless otherwise indicated.

2.5 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com/#sle.
 - 2. Clarion Safety Systems, LLC: www.clarionsafety.com/#sle.
 - 3. Insite Solutions, LLC: www.stop-painting.com/#sle.
 - 4. Seton Identification Products: www.seton.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches (178 by 254 mm) 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.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Boxes: Outside face of cover.
 - 9. Conductors and Cables: Legible from the point of access.
 - 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Secure rigid signs using stainless steel screws.
- G. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 260583
WIRING CONNECTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 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.

1.3 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.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Wiring Devices: As specified in Section 262726.
- B. Flexible Conduit: As specified in Section 260533.13.
- C. Wire and Cable: As specified in Section 260519.
- D. Boxes: As specified in Section 260533.16.

2.2 EQUIPMENT CONNECTIONS

- A. HVAC Equipment:
 - 1. Electrical Connection: Flexible conduit.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Occupancy sensors.
- B. Daylighting controls.

1.2 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, wall dimmers, and fan speed controllers.
- F. Section 265100 - Interior Lighting.
- G. Section 265600 - Exterior Lighting.

1.3 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. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
 - 3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
 - 4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
 - 5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 - 1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.
- C. Shop Drawings:
 - 1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.

2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.
- D. Field Quality Control Reports.
- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Include detailed information on device programming and setup.
- G. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 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.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.2 OCCUPANCY SENSORS

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 3. RAB Lighting, Inc: www.rablighting.com/#sle.
 4. Sensor Switch Inc: www.sensorswitch.com/#sle.
 5. WattStopper: www.wattstopper.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
 7. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. All Occupancy Sensors:
 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 2. Sensor Technology:
 - a. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.

3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
 5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
 6. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
 7. Sensitivity: Field adjustable.
 8. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
 9. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
- C. Wall Switch Occupancy Sensors:
1. All Wall Switch Occupancy Sensors:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
 - c. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
 - d. Finish: Match finishes specified for wiring devices in Section 262726, unless otherwise indicated.
 2. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet (83.6 sq m).
- D. Ceiling Mounted Occupancy Sensors:
1. All Ceiling Mounted Occupancy Sensors:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - c. Provide field selectable setting for disabling LED motion detector visual indicator.
 - d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
 2. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet (41.8 sq m) at a mounting height of 9 feet (2.7 m), with a field of view of 360 degrees.
- E. Power Packs for Low Voltage Occupancy Sensors:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
 2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
 3. Input Supply Voltage: Dual rated for 120/277 V ac.
 4. Load Rating: As required to control the load indicated on drawings.

2.3 DAYLIGHTING CONTROLS

- A. Manufacturers:

1. Hubbell Control Solutions: www.hubbell.com/hubbellcontrolsolutions/en/#sle. Hubbell Control Solutions: www.hubbell.com/hubbellcontrolsolutions/en/#sle. Hubbell Control Solutions: www.hubbell.com/hubbellcontrolsolutions/en/#sle.
 2. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 3. Sensor Switch Inc: www.sensorswitch.com/#sle.
 4. WattStopper: www.wattstopper.com/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
 6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.
- C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.
1. Sensor Type: Filtered silicon photo diode.
 2. Sensor Range:
 - a. Indoor Photo Sensors: 5 to 100 footcandles (53.8 to 1,080 lx).
 3. Finish: White unless otherwise indicated.
- D. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts, for direct continuous dimming of up to 50 ballasts.
- E. Daylighting Control Switching Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors, for switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
1. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
 2. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
 3. Control Capability:
 - a. Single Zone Switching Modules: Capable of controlling one programmable channel.
 - b. Multi-Zone Switching Modules: Capable of controlling up to three separately programmable channels.
- F. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts, for both continuous dimming of compatible dimming ballasts and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
1. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
 2. Control Capability: Capable of controlling up to three separately programmable channels, with up to 50 ballasts per channel.
 3. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
 4. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.
- G. Power Packs for Low Voltage Daylighting Control Modules:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
 2. Input Supply Voltage: Dual rated for 120/277 V ac.

3. Load Ratings: As required to control the load indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 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.

3.3 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of lighting control devices provided under this section.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.
- G. Provide required supports in accordance with Section 260529.
- H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- I. Identify lighting control devices in accordance with Section 260553.
- J. Occupancy Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
 - 2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet (1.2 m) from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.
- K. Daylighting Control Photo Sensor Locations:

1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for proper control of respective room or area based on manufacturer's recommendations for installed devices.
 2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
 3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.
- L. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.
- M. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
- E. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
- D. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.6 CLEANING

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

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.

END OF SECTION

SECTION 262300
LOW-VOLTAGE SWITCHGEAR

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low-voltage (600 V and less) standard (non-arc-resistant) metal-enclosed drawout switchgear and accessories for service and distribution applications.
- B. Low-voltage power circuit breakers for switchgear.

1.2 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.

1.3 REFERENCE STANDARDS

- A. ANSI C37.50 - American National Standard for Switchgear - Low Voltage AC Power Circuit Breakers Used In Enclosures - Test Procedures 2018.
- B. ANSI C37.51 - American National Standard for Switchgear - Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies - Conformance Test Procedures 2018.
- C. IEEE C37.13 - IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures 2015.
- D. IEEE C37.16 - IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers 2009.
- E. IEEE C37.17 - IEEE Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers 2022.
- F. IEEE C37.20.1 - IEEE Standard for Metal-Enclosed Low-Voltage (1000 Vac and Below, 3200 Vdc and Below) Power Circuit Breaker Switchgear 2015, with Amendment (2020).
- G. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- I. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- 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 1066 - Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures Current Edition, Including All Revisions.
- M. UL 1558 - Switchgear Current Edition, Including All Revisions.

1.4 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. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
5. Notify Architect of any conflicts with or deviations Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchgear, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, short-time current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of switchgear 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, and installation of product.
- E. Field Quality Control Test Reports.
- F. Project Record Documents: Record actual installed locations of switchgear and final equipment settings.
- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements, for additional provisions.
 2. Enclosure Keys: Two of each different key.
 3. Circuit Breakers:
 - a. Handles Necessary for Racking of Devices: One for each electrical room containing drawout switchgear.
 - b. Lifting Yokes: One of each different yoke required, for each electrical room containing drawout switchgear.
 - c. Removable Covers: One for blocking each different opening size when circuit breaker is temporarily removed from its compartment.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store switchgear in accordance with manufacturer's instructions and IEEE C37.20.1.
- B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchgear, which is not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
- C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle carefully to avoid damage to switchgear internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Low-Voltage Switchgear:
1. ABB: www.electrification.us.abb.com/#sle.
 2. Eaton Corporation: www.eaton.com/#sle.
 3. Schneider Electric: www.se.com/#sle.
 4. Siemens Industry, Inc: www.new.siemens.com/#sle.
 5. Source Limitations: Provide switchgear and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.2 LOW-VOLTAGE SWITCHGEAR

- A. Provide switchgear assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Dead-front standard (non-arc-resistant) type metal-enclosed drawout switchgear complying with IEEE C37.20.1 and ANSI C37.51; listed and labeled as complying with UL 1558; ratings, configurations and features as indicated on the drawings.
- D. Configuration:
1. Compartmentalization: Provide barriered compartments for each overcurrent protective device, distribution bus, and rear cable connection area.
 2. Arrangement: Rear accessible, front and rear aligned.
 3. Rear Access: Bolted covers.
- E. Service Conditions:
1. Provide switchgear and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude: Less than 6,600 feet (2,000 m).
 - b. Ambient Temperature: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).
- F. Short Circuit Current Rating:
1. Provide switchgear with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 2. Minimum Rating: 65,000 rms symmetrical amperes.
- G. Short-Time Current (30-Cycle Withstand) Rating: Equivalent to specified short circuit current rating.
- H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.
- I. Bussing: Sized in accordance with UL 1558 temperature rise requirements.
1. Main bus (horizontal cross bus) to be fully rated through full length of switchgear.
 2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 3. Provide solidly bonded equipment ground bus through full length of switchgear, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 4. Phase and Neutral Bus Material: Copper.

5. Ground Bus Material: Copper.
- J. Conductor Terminations: Suitable for use with the conductors to be installed.
 1. Line Conductor Terminations:
 - a. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - b. Main and Neutral Lug Type: Mechanical.
 2. Load Conductor Terminations:
 - a. Lug Material: Copper, suitable for terminating copper conductors only.
 - b. Lug Type:
 - 1) Provide mechanical lugs unless otherwise indicated.
- K. Enclosures:
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 2. Finish: Manufacturer's standard unless otherwise indicated.
- L. Future Provisions:
 1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- M. Owner Metering:
 1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
 2. Measured Parameters:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
 - b. Current (Amps): For each phase and neutral.
 - c. Frequency (Hz).
 - d. Real power (kW): For each phase, 3-phase total.
 - e. Reactive power (kVAR): For each phase, 3-phase total.
 - f. Apparent power (kVA): For each phase, 3-phase total.
 - g. Power factor.
 - h. Real energy (kWh).
 - i. Apparent energy (kVAh).
 - j. Current demand.
 - k. Power demand: Real, reactive, and apparent.
 3. Meter Accuracy: Plus/minus 1.0 percent.
- N. Instrument Transformers:
 1. Comply with IEEE C57.13.
 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 LOW-VOLTAGE POWER CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, trip-free low-voltage power circuit breakers with two-step stored energy closing mechanism; 100 percent rated; complying with IEEE C37.13, IEEE C37.16, IEEE C37.17, and ANSI C37.50; listed and labeled as complying with UL 1066; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity: Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated.
- C. Operation:
 1. Provide manually operated circuit breakers unless otherwise indicated.

- D. Construction: Drawout.
 - 1. Allows withdrawal of circuit breaker into test and disconnected positions, with racking position indication (connected, test, disconnected, withdrawn).
 - 2. Provide safety interlock to prevent racking of circuit breaker while in the ON position.
- E. Trip Units: Solid state, microprocessor-based, true rms sensing.

2.4 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Factory test switchgear according to IEEE C37.20.1, including the following production tests on each switchgear assembly or component:
 - 1. Dielectric tests.
 - 2. Mechanical operation tests.
 - 3. Grounding of instrument transformer cases test.
 - 4. Electrical operation and control wiring tests, including polarity and sequence tests.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the switchgear and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive switchgear.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install switchgear in accordance with NECA 1 (general workmanship) and IEEE C37.20.1.
- C. Arrange equipment to provide required clearances and maintenance access, including accommodations for drawout circuit breakers.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install switchgear plumb and level.
- F. Unless otherwise indicated, mount switchgear on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 033000.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Install all 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. Identify switchgear in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- C. Before energizing switchgear, perform preoperation checks in accordance with IEEE C37.20.1.
- D. Inspect and test in accordance with NETA ATS, except Section 4.
- E. Perform inspections and tests listed in NETA ATS, Section 7.1.
- F. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

- G. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.
- H. Correct deficiencies and replace damaged or defective switchgear assemblies or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of switchgear covers and doors.

3.5 CLEANING

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

3.6 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchgear 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.

3.7 PROTECTION

- A. Protect installed switchgear assemblies from subsequent construction operations.

END OF SECTION

SECTION 262416
PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Overcurrent protective devices for panelboards.

1.2 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.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e, with Amendment (2017).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards 2015.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- E. NEMA PB 1 - Panelboards 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less 2013.
- G. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- K. UL 67 - Panelboards Current Edition, Including All Revisions.
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- 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 of each different key.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

- E. Substitutions: See Section 016000 - Product Requirements.
- F. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet (2,000 m).
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- J. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum.
 - 2. Ground Bus Material: Aluminum.
- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
 - 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
 - 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 4. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

2.5 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.
- I. Provide grounding and bonding in accordance with Section 260526.
- J. Install all field-installed branch devices, components, and accessories.
- K. Provide filler plates to cover unused spaces in panelboards.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than _____ amperes. Tests listed as optional are not required.
- D. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

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

END OF SECTION

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SECTION 262726
WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Receptacles.
- B. Wall plates.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260533.16 - Boxes for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 260583 - Wiring Connections: Cords and plugs for equipment.
- E. Section 260923 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for 2014h, with Amendments (2017).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- C. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.
- D. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2020).
- E. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2021.
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 498 - Attachment Plugs and Receptacles Current Edition, Including All Revisions.
- H. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.
- I. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
 - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 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. GFCI Receptacles: Include information on status indicators.
- E. Project Record Documents: Record actual installed locations of wiring devices.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide tamper resistant receptacles for receptacles installed in dwelling units.
- E. Provide GFCI protection for receptacles installed within 6 feet (1.8 m) 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.

2.2 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: White with stainless steel wall plate.
- C. Wiring Devices Installed in Finished Spaces: White with stainless steel wall plate.
- D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
- E. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.

2.3 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
 - 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
 - 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
 1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 3. Tamper Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 4. Tamper Resistant and Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
 1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 3. Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 4. Tamper Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
 5. Tamper Resistant and Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.4 WALL PLATES

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.
 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

- D. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- E. Weatherproof Covers for Wet Locations: Gasketed, thermoplastic, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260533.16 as required for installation of wiring devices provided under this section.
 - 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 - 3. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

- L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- N. Identify wiring devices in accordance with Section 260553.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

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

END OF SECTION

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SECTION 265100
INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Exit signs.
- D. Ballasts and drivers.
- E. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 260529 - Hangers and Supports for Electrical Systems.
- B. Section 260533.16 - Boxes for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 260923 - Lighting Control Devices.
- E. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.
- F. Section 265600 - Exterior Lighting.

1.3 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 Lighting Systems 2006.
- F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems 2006.
- G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts 2020.
- H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012 (Reaffirmed 2018).
- I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 924 - Emergency Lighting and Power Equipment Current Edition, Including All Revisions.
- L. UL 1598 - Luminaires Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

1.4 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.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
 2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
- D. Field quality control reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 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.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide 3-year manufacturer warranty for LED luminaires, including drivers.
- C. Provide 5-year pro-rata warranty for batteries for emergency lighting units.
- D. Provide 10-year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 016000 - Product Requirements.

2.2 LUMINAIRES

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 3. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - 4. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 - 5. Philips Lighting North America Corporation: www.lightingproducts.philips.com/#sle.
 - 6. RAB Lighting, Inc: www.rablighting.com/#sle.
 - 7. Substitutions: See Section 016000 - Product Requirements.
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
- I. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- J. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.3 EMERGENCY LIGHTING UNITS

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 3. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

- B. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- C. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- D. Battery:
 - 1. Sealed maintenance-free lead calcium unless otherwise indicated.
 - 2. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- F. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
- H. Accessories:
 - 1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
 - 2. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.4 EXIT SIGNS

- A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single- or double-face as indicated or as required for installed location.
 - 2. Directional Arrows: As indicated or as required for installed location.
- B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.
 - 1. Manufacturers:
 - a. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - b. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - c. Hubbell Lighting, Inc: www.hubbellighting.com/#sle.
 - d. Philips Lighting North America Corporation: www.lightingproducts.philips.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- C. Accessories:
 - 1. Provide compatible accessory high-impact polycarbonate vandal shields where indicated.
 - 2. Provide compatible accessory wire guards where indicated.

2.5 BALLASTS AND DRIVERS

- A. Manufacturers:
 - 1. Alloy LED: www.alloyled.com/#sle.
 - 2. California Accent Lighting, Inc: www.calilighting.com/#sle.
 - 3. General Electric Company/GE Lighting: www.gelighting.com/#sle.
 - 4. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 - 5. OSRAM Sylvania, Inc: www.osram.us/ds/#sle.
 - 6. Philips Lighting North America Corporation: www.usa.lighting.philips.com/#sle.
 - 7. Substitutions: See Section 016000 - Product Requirements.
 - 8. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.

9. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.
- B. Ballasts/Drivers - General Requirements:
 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
 3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.
- C. Dimmable LED Drivers:
 1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
 2. Control Compatibility: Fully compatible with the dimming controls to be installed.
 - a. Daylighting Controls: See Section 260923.

2.6 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

3.1 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.

3.2 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.

3.3 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. Install accessories furnished with each luminaire.
- J. Bond products and metal accessories to branch circuit equipment grounding conductor.
- K. Emergency Lighting Units:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
- L. Exit Signs:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 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.

3.6 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.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

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SECTION 265600
EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior luminaires.
- B. Ballasts.
- C. Luminaire accessories.

1.2 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 260923 - Lighting Control Devices.
- E. Section 262726 - Wiring Devices: Receptacles for installation in poles.
- F. Section 265100 - Interior Lighting.

1.3 REFERENCE STANDARDS

- A. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products 2019.
- B. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources 2021.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- D. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems 2000 (Reaffirmed 2006).
- E. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts 2020.
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 1598 - Luminaires Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. 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.
 - b. Include IES LM-79 test report upon request.
- C. Field Quality Control Reports.
 - 1. Include test report indicating measured illumination levels.

- 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. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- F. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.6 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.

1.7 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.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide 2-year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 016000 - Product Requirements.

2.2 LUMINAIRES

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 3. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - 4. Philips Lighting North America Corporation: www.lightingproducts.philips.com/#sle.
 - 5. RAB Lighting, Inc: www.rablighting.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

2.3 BALLASTS AND DRIVERS

- A. Manufacturers:
 - 1. California Accent Lighting, Inc; www.calilighting.com/#sle.
 - 2. General Electric Company/GE Lighting: www.gelighting.com/#sle.
 - 3. OSRAM Sylvania, Inc: www.osram.us/ds/#sle.
 - 4. Philips Lighting North America Corporation; www.usa.lighting.philips.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
 - 6. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.
 - 7. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.
- B. Ballasts/Drivers - General Requirements:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
 - 3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 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 in accordance with NECA/IESNA 501.
- 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. Install accessories furnished with each luminaire.
- H. Bond products and metal accessories to branch circuit equipment grounding conductor.
- I. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.

- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.
- E. Measure illumination levels at night with calibrated meters to verify compliance with performance requirements. Record test results in written report to be included with submittals.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.6 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.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 271000
STRUCTURED CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Communications outlets.
- E. Communications grounding and bonding.
- F. Communications identification.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260533.16 - Boxes for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products.
- E. Section 262726 - Wiring Devices.
- F. Section 270533.13 - Conduit for Communications Systems.

1.3 REFERENCE STANDARDS

- A. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition 2019.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set 2020.
- D. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards 2018d, with Addenda (2020).
- E. TIA-569 - Telecommunications Pathways and Spaces 2019e.
- F. TIA-606 - Administration Standard for Telecommunications Infrastructure 2021d.
- G. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises 2019d.
- H. UL 444 - Communications Cables Current Edition, Including All Revisions.
- I. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers Current Edition, Including All Revisions.
- J. UL 1863 - Communications-Circuit Accessories Current Edition, Including All Revisions.

1.4 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.

1.5 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. Evidence of qualifications for installer.
- D. Field Test Reports.
- E. 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.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.8 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

2.1 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. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
 2. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F (0 to 60 degrees C) at relative humidity of 0 to 95 percent, noncondensing.
 3. 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): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.
 1. Locate main distribution frame in Telecommunications Room.
- C. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
 1. Locate intermediate distribution frames in Telecommunications Room(s) on each floor.
- D. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.2 PATHWAYS

- A. Conduit: See section 270533.13.
- B. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

2.3 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. Provide cables with lead content less than 300 parts per million.
- C. 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 6 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 - Voice and Data Cable: Blue.
 - 6. Product(s):
 - a. CommScope; SYSTIMAX Twisted Pair Cables; GigaSPEED XL Category 6 U/UTP Cable: www.commscope.com/#sle.
 - b. CommScope; Uniprise Twisted Pair Cables; CS34 Series Category 6 U/UTP Cable: www.commscope.com/#sle.
 - c. General Cable Technologies Corporation; GenSPEED Cables: www.generalcable.com/#sle.
- D. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- E. 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; MGS400 Series Category 6 U/UTP Modular Jacks: www.commscope.com/#sle.
 - b. CommScope; Uniprise RJ45 Jacks; UNJ600 Series Category 6 U/UTP Modular Jacks: www.commscope.com/#sle.
- F. 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. Product(s):
 - a. CommScope; SYSTIMAX Category 6 U/UTP Patch Cords: www.commscope.com/#sle.
 - b. CommScope; Uniprise Category 6 U/UTP Patch Cords: www.commscope.com/#sle.

2.4 COMMUNICATIONS OUTLETS

- A. Manufacturers:
 - 1. CommScope: www.commscope.com/#sle.
 - 2. Siemon Company: www.siemon.com/#sle.
- 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.
 - 4. Wall Plate Material/Finish - Flush-Mounted Outlets: High impact thermoplastic, color to be selected.

2.5 GROUNDING AND BONDING COMPONENTS

- A. Comply with TIA-607.
- B. Comply with Section 260526.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. Comply with Section 260553.

2.7 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION OF PATHWAYS

- A. Install pathways with the following minimum clearances:
 - 1. 48 inches (1220 mm) from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches (300 mm) from power conduits and cables and panelboards.
 - 3. 5 inches (125 mm) from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches (150 mm) from flues, hot water pipes, and steam pipes.
- B. 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: Unless otherwise indicated, as follows:
 - 1) Telephone and Data Outlets: 18 inches (450 mm) above finished floor.
 - b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.

- c. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
- d. Locate outlet boxes so that wall plate does not span different building finishes.
- e. Locate outlet boxes so that wall plate does not cross masonry joints.

3.3 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 (3000 mm).
 - 2. At Outlets - Copper: 12 inches (305 mm).
- C. Copper Cabling:
 - 1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch (12 mm) from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds (110 N) pull tension.
 - 3. Use T568B wiring configuration.
- D. 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.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - 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:
- E. 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

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SECTION 27 05 11**REQUIREMENTS FOR COMMUNICATIONS SYSTEMS****PART 1 GENERAL****1.01 DESCRIPTION**

- A. This Section, Requirements for Communications Installations, applies to all sections of Division 27.
- B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, and other items and arrangements for the specified items are shown on drawings.

1.02 MINIMUM REQUIREMENTS

- A. References to industry and trade association standards and codes are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.03 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
 - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 - 2. The Owner reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.04 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.

4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
 1. The Owner shall have the option of witnessing factory tests. The contractor shall notify the Owner a minimum of 15 working days prior to the manufacturers making the factory tests.
 2. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of the tests.
 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Owner.

1.05 EQUIPMENT REQUIREMENTS

- A. Where variations from the contract requirements are requested in accordance with the GENERAL CONDITIONS, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.06 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
 1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
 2. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
 4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.07 1.7 WORK PERFORMANCE

- A. Job site safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by GENERAL CONDITIONS.
- D. Coordinate location of equipment and pathways with other trades to minimize interferences. See the GENERAL CONDITIONS.

1.08 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Inaccessible Equipment:
 - 1. Where the Owner determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
 - 2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.09 EQUIPMENT IDENTIFICATION

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

1.10 SUBMITTALS

- A. Submit in accordance with GENERAL CONDITIONS.
- B. The Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION _____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. Submit each section separately.
- E. The submittals shall include the following:
 - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 - 2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.

3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- F. Manuals: Submit in accordance with GENERAL CONDITIONS.
1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
 2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
 3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
 4. The manuals shall include:
 - a) Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b) A control sequence describing start-up, operation, and shutdown.
 - c) Description of the function of each principal item of equipment.
 - d) Installation and maintenance instructions.
 - e) Safety precautions.
 - f) Diagrams and illustrations.
 - g) Testing methods.
 - h) Performance data.
 - i) Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j) Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.

1.11 TRAINING

- A. Training shall be provided in accordance with the GENERAL CONDITIONS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Engineer at least 30 days prior to the planned training.

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SECTION 27 05 26**GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS****PART 1 - GENERAL****1.01 DESCRIPTION**

- A. This section specifies general grounding and bonding requirements of telecommunication installations for equipment operations.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.02 RELATED WORK

- A. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 27.
- B. Section 27 10 00, STRUCTURED CABLING: Low Voltage power and lighting wiring.

1.03 SUBMITTALS

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of above-ground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Engineer:
 - 1. Certification that the materials and installation is in accordance with the drawings and specifications.
 - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.04 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. American Society for Testing and Materials (ASTM):
 - 1. B1-2001 Standard Specification for Hard-Drawn Copper Wire
 - 2. B8-2004 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

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- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. 81-1983 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
 - 1. 70-2005 National Electrical Code (NEC)
 - 2. Telecommunications Industry Association, (TIA)
- D. J-STO-607-A-2002 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 1. E. Underwriters Laboratories, Inc. (UL):
 - 2. 44-2005 Thermoset-Insulated Wires and Cables
 - 3. 83-2003 Thermoplastic-Insulated Wires and Cables
 - 4. 467-2004 Grounding and Bonding Equipment
 - 5. 486A-486B-2003 Wire Connectors

PART 2 - PRODUCTS**2.01 GROUNDING AND BONDING CONDUCTORS**

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.
- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.
- C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.
- D. Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 50mm² (1/0 AWG) insulated stranded copper grounding conductor unless indicated otherwise.

2.02 GROUND RODS

- A. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance.

2.03 SPLICES AND TERMINATION COMPONENTS

- A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.04 TELECOMMUNICATION SYSTEM GROUND BUSBARS

- A. Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 6 mm (1/4 inch) for wall and backboard mounting using standard insulators sized as follows:
 - 1. Room Signal Grounding: 300 mm x 100 mm (12 inches x 4 inch).

2. Master Signal Ground: 600 mm x 100 mm (24 inches x 4 inch).

2.05 GROUND CONNECTIONS

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
 3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.
- C. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

2.06 EQUIPMENT RACK AND CABINET GROUND BARS

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x 3/4 inch).

2.07 GROUND TERMINAL BLOCKS

- A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.08 SPLICE CASE GROUND ACCESSORIES

- A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

PART 3 - EXECUTION

3.01 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
 3. Isolation transformers and isolated power systems shall not be system grounded.
- C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

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3.02 INACCESSIBLE GROUNDING CONNECTIONS

- A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.03 SECONDARY EQUIPMENT AND CIRCUITS

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
 - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
 - 2. Provide a supplemental ground electrode and bond to the grounding electrode system.
- C. Conduit Systems:
 - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 - 2. Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
 - 3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.
- D. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- E. Boxes, Cabinets, Enclosures, and Panelboards:
 - 1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
 - 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 - 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- F. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.
- G. Raised Floors: Provide bonding of all raised floor components. //See details on the drawings.

3.04 CORROSION INHIBITORS

- A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

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3.05 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- B. In operating rooms and at intensive care and coronary care type beds, bond the gases and suction piping, at the outlets, directly to the room or patient ground bus.

3.06 TELECOMMUNICATIONS SYSTEM

- A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.
- B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.
- D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milli ohms or less.
- E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Engineer prior to backfilling any ground connections.
- F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.
- G. Bonding Jumpers:
 - 1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 16 mm² (6 AWG) insulated copper wire.
 - 2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
 - 3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.
- H. Bonding Jumper Fasteners:
 - 1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
 - 2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
 - 3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.

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4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

3.07 COMMUNICATION ROOM GROUNDING

- A. Telecommunications Ground Busbars:
 1. Provide communications room telecommunications ground busbar hardware at 950 mm (18 inches) at locations indicated on the Drawings.
 2. Connect the telecommunications room ground busbars to other room grounding busbars as indicated on the Grounding Riser diagram.
- B. Telephone-Type Cable Rack Systems: aluminum pan installed on telephone-type cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:
 1. Install a 16 mm² (6 AWG) bonding between the telecommunications ground busbar and the nearest access to the aluminum pan installed on the cable rack.
 2. Use 16 mm² (6 AWG) bonding jumpers across aluminum pan junctions.
- C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:
 1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using solid copper splice plates supplied by the ground bar manufacturer.
 2. Bond together nonadjacent ground bars on equipment racks and cabinets with 16 mm² (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
 3. Provide a 16 mm² (6 AWG) bonding jumper between the rack and/or cabinet ground busbar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.
- D. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 mm² (16 AWG) bonding jumper.
- E. Other Communication Room Ground Systems: Ground all metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground busbar, whichever is closer, using insulated 16 mm² (6 AWG) ground wire bonding jumpers.

3.08 COMMUNICATIONS CABLE GROUNDING

- A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
 1. At terminal points, install a cable shield bonding connector provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.

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2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

3.09 COMMUNICATIONS CABLE TRAY SYSTEMS:

- A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout this cable tray systems as follows:
 1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Subcontractor shall verify this loss by testing across one splice plate connection in the presence of the Contractor.
 2. Install a 16 mm² (6 AWG) bonding jumper across each cable tray splice or junction where splice plates cannot be used.
 3. When cable tray terminations to cable rack, install 16 mm² (6 AWG) bonding jumper between cable tray and cable rack pan.

3.10 COMMUNICATIONS RACEWAY GROUNDING

- A. Conduit: Use insulated 16 mm² (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
- B. Wireway: use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.
- C. Cable Tray Systems: Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 16 meters (50 feet).

3.11 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.

3.12 GROUND ROD INSTALLATION

- A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.

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- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.
- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION

SECTION 27 05 28**INTERIOR PATHWAYS****PART 1 - GENERAL****1.01 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for all communications cabling unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.
- C. Provide all labor, materials, tools and equipment required for the complete installation of work called for in the contract documents.

1.02 RELATED WORK

- A. Bedding of conduits.
- B. Mounting board for communication closets.
- C. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- D. Fabrications for the deflection of water away from the building envelope at penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- E. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building
- F. Identification and painting of conduit and other devices.
- G. General electrical requirements and items that is common to more than one section of Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- H. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.03 SUBMITTALS

In accordance with GENERAL CONDITIONS, furnish the following:

- A. Shop Drawings:
 - 1. Size and location of panels and pull boxes
 - 2. Layout of required conduit penetrations through structural elements.
 - 3. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Certification: Prior to final inspection, deliver to the Engineer A certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.04 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
 - 1. 70-05 National Electrical Code (NEC)
- C. Underwriters Laboratories, Inc. (UL):
 - 1. 1-03 Flexible Metal Conduit
 - 2. 5-01 Surface Metal Raceway and Fittings
 - 3. 6-03 Rigid Metal Conduit
 - 4. 50-03 Enclosures for Electrical Equipment
 - 5. 360-03 Liquid-Tight Flexible Steel Conduit
 - 6. 467-01 Grounding and Bonding Equipment
 - 7. 514A-01 Metallic Outlet Boxes
 - 8. 514B-02 Fittings for Cable and Conduit
 - 9. 514C-05 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
 - 10. 651-02 Schedule 40 and 80 Rigid PVC Conduit
 - 11. 651A-03 Type EB and A Rigid PVC Conduit and HDPE Conduit
 - 12. 797-03 Electrical Metallic Tubing
 - 13. 1242-00 Intermediate Metal Conduit
- D. National Electrical Manufacturers Association (NEMA):
 - 1. TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
 - 2. FB1-03 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 2 - PRODUCTS**2.01 CONDUIT:**

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (1/2 inch) unless otherwise shown.
 - 1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
 - 2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
 - 3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
 - 4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
 - 5. Flexible galvanized steel conduit: Shall Conform to UL 1.
 - 6. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
 - 7. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high-density polyethylene (PE).

8. Surface metal raceway: Shall Conform to UL 5.

2.02 CONDUIT FITTINGS:

A. Rigid steel and IMC conduit fittings:

1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
3. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
4. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
5. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
6. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

B. Rigid aluminum conduit fittings:

1. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
2. Locknuts and bushings: As specified for rigid steel and IMC conduit.
3. Set screw fittings: Not permitted for use with aluminum conduit.

C. Electrical metallic tubing fittings:

1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
2. Only steel or malleable iron materials are acceptable.
3. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
4. Indent type connectors or couplings are prohibited.
5. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.

D. Flexible steel conduit fittings:

1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
2. Clamp type, with insulated throat.

E. Liquid-tight flexible metal conduit fittings:

1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
2. Only steel or malleable iron materials are acceptable.

3. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- F. Direct burial plastic conduit fittings:
 1. Fittings shall meet the requirements of UL 514C and NEMA TC3.
 2. As recommended by the conduit manufacturer.
- G. Surface metal raceway fittings: As recommended by the raceway manufacturer.
 1. Expansion and deflection couplings:
 - a) Conform to UL 467 and UL 514B.
 - b) Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30-degree angular deflections.
 - c) Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
 - d) Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

2.03 CONDUIT SUPPORTS:

- A. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
- B. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
- C. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
- D. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

2.04 OUTLET, JUNCTION, AND PULL BOXES:

- A. UL-50 and UL-514A.
- B. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
- C. Sheet metal boxes: Galvanized steel, except where otherwise shown.
- D. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.

2.05 WIREWAYS:

- A. Equip with hinged covers, except where removable covers are shown.

2.06 INNERDUCT:

- A. Standard HDPE
 1. Textile Innerduct: Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape as manufactured by MaxCell:
 - a) MaxCell Group/TVC Communications

- b) 600 Plum Creek Dr.
 - c) Wadsworth, OH. 44281
 - d) 1-888-387-3828
2. Textile innerduct fittings
- a) Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.: a 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
 - b) Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.
 - c) Pull Tape: measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.

2.07 SURFACE METALLIC RACEWAY

- A. Refer to drawings for additional surface raceway sizes, cable fill tables, and cable radius requirements.
- B. TYPE SR-2 (V2400 series)
- 1. .875" H x 1.875" W
 - 2. Metallic two-piece raceway with single compartment.
 - 3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
 - 4. Refer to Drawings for additional information and requirements.
 - 5. Provide the following fittings:
 - a) Entrance end fitting - nominal maximum dimensions of 2.62" W x 2.25" H x 3" L. and 1" conduit knockout.
 - b) Back entrance end fitting - same as entrance end fitting with internal radius.
 - c) Tee fittings to connect to SR-3 (3000 Series) and SR-4 (4000 Series) raceway where T section to SR-2 (2400 Series) has maximum width equal to SR-2 raceway
 - d) Bridge fitting with radius for spanning existing raceways in varying widths from ½" to 2.
 - e) Flat Internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A. Internal or external radius control must be provided. Derate fill capacities when internal radius control is provided, as recommended by the manufacturer.
 - f) Surface 2" x 4" or 4" x 4" boxes, with 2.25" depth as called for.
 - 6. Design Make: Wiremold V2400 series raceway, V2475D series bridge fittings, V2410 series entrance end fittings, V2415 T fittings.
 - 7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.
- C. TYPE SR-3 (V3000 Series)
- 1. 1.5" H x 2.75"W
 - 2. Metallic two piece raceway with single compartment.

3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
 4. Refer to Drawings for additional information and requirements.
 5. Provide the following fittings:
 - a) Entrance end fitting - nominal maximum dimensions of 2.75"W x 2"H x 2.125" L. and 1" conduit knockout.
 - b) Back entrance end fitting - same as entrance end fitting with internal radius.
 - c) Tee fittings to connect to SR-2 (2400 Series) raceway where T section to SR-2 has maximum width equal to SR-2 raceway
 - d) Flat Internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A using internal or external radius components. Internal or external radius control must be provided. Derate fill capacities when internal radius control is provided, as recommended by the manufacturer.
 6. Design Make: Wiremold V3000 series raceway, with V3011, V3010 and V3018 fittings.
 7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.
- D. TYPE SR-4 and SR-4d (V4000 Series)
1. 1.75" H x 4.75" W
 2. Metallic two-piece raceway with single or divided compartment as called for on plans.
 3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
 4. Provide the following fittings:
 - a) Entrance end fitting - nominal maximum dimensions of 4.75" W x 2.75"H x 6.5" L. and 1.25" conduit knockout.
 - b) Back entrance end fitting - same as entrance end fitting with internal radius.
 - c) T fittings to connect to SR-2 (2400 Series) raceway where T section to SR-2 has maximum width equal to SR-2 raceway
 - d) Flat Internal and external elbows with fiber optic radius
 5. Design Make: Wiremold V4000 Series raceway, with V4010, V4017FO, V4015FO and V4011FO fittings.
 6. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal
- E. TYPE SR-7 (V700 Series)
1. One-piece raceway
 2. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
 3. Utilized for wall mounted phones and miscellaneous branch circuit power only.
 4. Provide internal and external 90-degree fittings with radius.
 5. Provide miscellaneous boxes, extension rings, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.
 6. Design Make: Wiremold V700

7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.

2.08 WIRE MESH CABLE TRAY

- A. Cable Tray Finish: Carbon Steel with Zink plating.
- B. Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe/T/Edge T/welded top side wire to protect cable insulation and installers.
- C. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.
 1. Mesh: 2 x 4 inches (50 x 100 mm).
 2. Straight Section Lengths: 118 inches (3,000 mm).
 3. Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray strength; and to allow tray to remain lightweight.
 4. Safe/T/Edge: Patented Safe/T/Edge technology on side wire to protect cable insulation and installers' hands.
 5. Fittings: Wire mesh cable tray fittings are field/fabricated from straight tray sections, in accordance with manufacturer's instructions and Item 2.3.
 6. CF Series Cable Tray Size:
 7. Depth: Cable tray shall be available in the following depths:
 - a) [1 inch (30 mm)]
 - b) [2 inches (54 mm)]
 - c) [4 inches (105 mm)]
 - d) [6 inches (150 mm)]
 8. Width: Cable tray width will be available in the following widths:
 - a) [2 inches (50 mm)]
 - b) [4 inches (100 mm)]
 - c) [6 inches (150 mm)]
 - d) [8 inches (200 mm)]
 - e) [12 inches (300 mm)]
 - f) [18 inches (450 mm)]
 - g) [20 inches (500 mm)]
 - h) [24 inches (600 mm)]
 9. Length: Cable tray section length will be 118 inches (3000mm) unless otherwise shown on drawings.
- D. Support cable tray as recommended by manufacture. Provide a safety loading factor of 1.5 for uniformly distributed loads when supported as a simple span in accordance with the NEMA standard listed.
- E. Refer to drawing for additional Cable Tray details and requirements
- F. Design Makes: Legrand Cablofil Wire Mesh

G. Acceptable Manufacturers:

1. Cooper B/line Flextray
2. Approved equal

2.09 CABLE HANGERS (J-HOOK)

- A. Provide prefabricated, zinc coated, carbon steel hangers designed specifically for UTP and Optical Fiber cable installations.
- B. Hangers shall have open top, rolled edges and a 3" or 4" minimum diameter loop.
- C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.
- D. Design Make CADDY CAT CM

2.10 COMMUNICATIONS/POWER POLES

- A. Provide aluminum multi-service power pole.
- B. Pole shall include 2 electrically isolated channels to act as raceway for communications cabling and future electrical wiring.
- C. Include ceiling trim plate, low voltage entrance fitting, T-bar mounting bracket and carpet / floor grippers.
- D. Design Make: Legrand TPP series or approved equal

2.11 Floor Boxes

- A. ACCEPTABLE MANUFACTURERS
 1. FSR
 - a) FL-500P-4
 - b) COVER PART# FL-500P-PLP-GRY-C

PART 3 - EXECUTION**3.01 PENETRATIONS**

- A. Cutting or Holes:
 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Engineer prior to drilling through structural sections.
 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Engineer as required by limited working space.
- B. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

3.02 INSTALLATION, GENERAL**A. Install conduit as follows:**

1. In complete runs before pulling in cables or wires.
2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
5. Mechanically continuous.
6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
12. Do not use aluminum conduits in wet locations.
13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.

B. Conduit Bends:

1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

C. Layout and Homeruns:

1. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Engineer.

3.03 CONCEALED WORK INSTALLATION**A. In Concrete:**

1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only when the following occurs:
 - a) Where shown on the structural drawings.

- b) As approved by the Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
 - 4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
 - a) Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
 - b) Space between conduits in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
 - c) Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (3/4 inch) of concrete around the conduits.
 - 5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.
- B. Furred or Suspended Ceilings and in Walls:
- 1. Conduit for conductors 600 volts and below:
 - a) Rigid steel, IMC, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
 - 2. Align and run conduit parallel or perpendicular to the building lines.
 - 3. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.
 - 4. Tightening set screws with pliers is prohibited.

3.04 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 volts and below:
 - 1. Rigid steel, IMC, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- F. Surface metal raceways: Use only where shown.
- G. Painting:
 - 1. Paint exposed conduit.

3.05 EXPANSION JOINTS

- A. Conduits 75 mm (3 inches) and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper

green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.

- C. Install expansion and deflection couplings where shown.
- D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

3.06 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - 2. Existing Construction:
 - a) Steel expansion anchors not less than 6 mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.
 - b) Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
 - c) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.07 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush mounted.

2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example, "SIG-FA JB No. 1".

3.08 COMMUNICATION SYSTEM CONDUIT

- A. Install the communication raceway system as shown on drawings.
- B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.
- C. All conduit ends shall be equipped with insulated bushings.
- D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90-degree bends. Size boxes per the NEC.
- E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.
- F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.
- G. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- H. All empty conduits located in communication closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
- I. Conduit runs shall contain no more than four quarter turns (90-degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

Sizes of Conduit Trade Size	Radius of Conduit Bends mm, Inches
3/4	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

- J. Furnish and install 19 mm (3/4 inch) thick fire-retardant plywood specified in Section 06 10 00, ROUGH CARPENTRY on the wall of communication closets where shown on drawings. Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.
- K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).
- L. Furnish SMART LB Fittings shall be utilized on all communication conduits. Refer to www.smartlb.com for additional information. Smart LB Die cast Aluminum LB fitting shall be used with Liquidtight, "EMT", "IMC" or "Rigid" Metallic conduit and fittings. Smart LB PVC LB fitting shall be used with Sch 40 rigid PVC, "Sch 80 rigid PVC", "ENT", "PVC Flex Duct", "PVC General Purpose Duct", "PVC Riser Duct", Type NM Liquidtight conduit and "rigid nonmetallic Power and Communication Ducts"
- M. Textile Innerduct (MaxCell):
1. Aboveground, Exterior and Interior Conduit Installations: Outdoor textile innerduct (Standard or Detectable as desired).
 2. Interior Exposed Locations
 - a) Non-plenum Areas: Indoor textile innerduct
 - b) Plenum Areas: Plenum-listed indoor innerduct
 3. When installed in 4" conduit, use two 3" 3-Cell packs with an additional pull tape on the outside for future pulls in each conduit.
 4. Cable Tray: use standard outdoor or indoor textile innerduct

END OF SECTION

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SECTION 27 10 00**STRUCTURED CABLING GENERAL REQUIREMENTS****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
 - 1. Contract Documents
 - 2. Division 00 –Procurement & Contracting Requirements Group
 - 3. Division 1 – General Requirements
 - 4. Section 27 11 00 – Equipment Room Fittings
 - 5. Section 27 13 00 – Backbone Cabling
 - 6. Section 27 15 00 – Horizontal Cabling CAT 6

1.02 REFERENCES

- A. All work shall be performed in accordance with the following Codes and industry Standards, unless noted otherwise:
 - 1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
 - 2. TIA/EIA 568-B – Commercial Building Telecommunications Cabling Standard, current version.
 - 3. TIA/EIA 569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
 - 4. TIA/EIA 606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
 - 5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
 - 6. IEEE 241 – IEEE Recommended Practice for Electric Power Systems in Commercial Buildings, pertaining to communication systems.
 - 7. TIA/EIA 758-A – Customer-Owned Outside Plant Telecommunications Cabling Standard

1.03 WARRANTY

- A. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.

1.04 SUMMARY

- A. This Section includes general requirements specifically applicable to Division 27.
- B. The Contractor shall be responsible for:

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1. Providing all additional materials, and the necessary labor and services required to ensure all components of the system are completely installed in accordance with the intent of the Contract Documents.
 2. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
 3. Coordinating the details of facility equipment and construction for all specification divisions that affect the work covered under this Division.
 4. Coordinating all activities with the overall construction schedule.
 5. Developing bill of materials, perform material management and efficient use of the materials whether they are issued by the Contractor, the owner or purchased by the Contractor.
 6. Ensure materials in excess of those required to complete the project are kept in their original condition and packaging for restocking.
 7. Ensure project is properly registered for the specified manufacturer's copper & fiber cable extended warranty programs.
- C. Intent of Drawings:
1. Communications plan drawings show only general locations of equipment, devices, raceways, cable trays, boxes, etc. All dimensioned locations and elevations are approximate. The Contractor is responsible for the field coordination of communications work with the other trades prior to beginning work.
 2. The Contractor shall be responsible for the proper placement and routing of equipment, cable, raceways, cable tray, and related components according to the Contract Documents and subject to prior review by Designer.
 3. Refer all conflicts between Contract Documents to contractor for resolution.

1.05 DEFINITIONS

- A. Active Equipment: Electronic equipment used to develop various WAN and LAN services.
- B. Backbone: Collective term sometimes used to describe the campus and vertical distribution subsystem facilities and media interconnecting service entrances, communications rooms, and communications cabinets.
- C. Bonding: Permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed on it.
- D. Building Equipment Room (BER): Room in each building used to distribute communications services to Telecommunications Rooms (TR) in the same building. Typically, the BER contains passive equipment used for electrical protection (protectors) and building cross-connect, and active network equipment used for LANs. The BER may also serve the function of a TR.
- E. Cabinet: Freestanding, floor-mounted modular enclosure designed to house and protect rack-mounted electronic equipment.
- F. Cable Tray: Vertical or horizontal open supports usually made of aluminum or steel that is fastened to a building ceiling or wall. Cables are laid in and fastened to the trays. A cable tray is not a raceway.

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- G. Campus: Grounds and buildings of a multi-building premises environment.
- H. Channel: The end-to-end transmission path between two points at which application specific equipment is connected; may include one or more links, cross-connect jumper and/or patch cords, and work area station cords. Does not include connection to active equipment.
- I. Communications Equipment Room –See Telecommunications Room (TR)
- J. Cross-Connect: Equipment used to terminate and tie together communications circuits.
- K. Cross-Connect Jumper: A cluster of twisted-pair conductors without connectors used to establish a circuit by linking two cross-connect termination points.
- L. Fiber Optic Distribution Unit (FDU): Cabinet with terminating equipment used to develop fiber optic cross-connect facilities.
- M. Grounding: A conducting connection to earth, or to some conducting body that serves in place of earth.
- N. Hinged Cover Enclosure: Wall-mounted box with a hinged cover that is used to house and protect electrical devices.
- O. Horizontal: Pathway facilities and media connecting Telecommunications Rooms (TR) to Telecommunications Outlets (TO).
- P. Innerduct: Flexible sheath used to enclose cables and protect them from damage. It is commonly used when running fiber optic cable through underground conduits originally designed for large-diameter telephone cables. Max-Cell Innerduct is a fabric based innerduct that enables a higher density of communication cables to be pulled.
- Q. Jack: Receptacle used in conjunction with a plug to make electrical contact between communications circuits, e.g., eight-position/eight-contact modular jacks.
- R. Link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables; one continuous section of conductors or fiber, including the connecting hardware at each end.
- S. Local Area Network (LAN): Data transmission facility connecting a number of communicating devices, e.g., serial data, Ethernet, token ring, etc. Typically, the network is limited to a single site.
- T. Main Equipment Room (MER): The room used to distribute communication services to all Building Equipment Rooms (BER's) on the premises, and to interconnect premises services with the telephone companies. Typically, the MER contains passive equipment used for electrical protection (protectors) and main campus cross-connect, and active equipment used for PBX, WAN, and LAN.
- U. Media: Twisted-pair, coaxial, and fiber optic cable or cables used to provide signal transmission paths.
- V. Mounting Frame: Rectangular steel framework which can be equipment rack or wall mounted to support wiring blocks, patch panels, and other communications equipment.
- W. Passive Equipment: Non-electronic hardware and apparatus, e.g., equipment racks, cable trays, electrical protection, wiring blocks, fiber optic termination hardware, etc.
- X. Patch Cords: A length of wire or fiber cable with connectors on one or both ends used to join communications circuits at a cross-connect.

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- Y. Patch Panel: System of terminal blocks or connectors used with patch cords that facilitate administration of cross-connect fields.
- Z. Pathway: Facility for the placement of communications cable. A pathway facility can be composed of several components including conduit, wireway, cable tray, surface raceway, underfloor systems, raised floor, ceiling support wires, etc.
- AA. Private Branch Exchange (PBX): Private communications switching system located on the user's premises. A PBX switches voice and data calls within a building or premises and between the premises and facilities provided by public common carrier networks.
- BB. Protectors: Electrical protection devices used to limit foreign voltages on metallic communications circuits.
- CC. Raceway: An enclosed channel designed expressly for holding wires or cables; may be of metal or insulating material. The term includes conduit, tubing, wireway, underfloor raceway, and surface raceway; does not include cable tray.
- DD. Racks: An open, freestanding, floor-mounted structure, typically made of aluminum or steel, used to mount equipment; usually referred to as an equipment rack.
- EE. Telecommunication Outlet (TO): Connecting device mounted in a work area used to terminate horizontal cable and interconnect cabling with station equipment.
- FF. Telecommunications Room (TR): Distributes communications services to users within a serving zone and interconnects with the BER. Typically, the TER contains passive equipment used for cross-connect and active network equipment used for LANs. TR is sometimes referred to as the communications equipment room.
- GG. Wide Area Network (WAN): Active communications transmission facilities extending beyond the premises.
- HH. Wiring Block: Punch down terminating equipment used to develop twisted-pair cross-connect facilities.

1.06 SYSTEM DESCRIPTION

- A. The Owner will implement a comprehensive integrated communications distribution system, as described in paragraph B below, to provide wiring infrastructure which may be used to support one or more of the following services and systems:
 - 1. Voice & Data Telecommunications.
 - 2. Mass Notification Systems.
- B. The communications distribution system consists of the following major subsystems, as specified elsewhere:
 - 1. Inter-building Backbone: The inter-building subsystem refers to all twisted pair and fiber optic backbone communications cabling connecting the Main Building Equipment Room (BER) to each building equipment room (BER) in all buildings on the campus / region. This project includes modification to the fiber backbone as shown on the drawings and further detailed in the Specifications.
 - 2. Intra-building Backbone: The intra-building subsystem refers to all twisted-pair and fiber optic backbone communications cabling connecting the Main Telecommunications Room (TR) to each Telecommunication Room (TR) in the buildings.

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3. Communication Rooms: The communications room contains the distribution subsystem comprised of the passive components used to terminate cabling subsystems and distribute communications services. This subsystem includes installations in the Building Equipment Rooms (BERs), in Telecommunications Rooms (TRs) and Telecommunications Enclosures (TEs). Complete work as shown in the drawings and as specified in Section 271100.
 4. Horizontal Distribution: Horizontal distribution building cable to telecommunication outlets (TOs). Section 271500 is included for termination & testing required for the installation of Cat 6 patch panels in the Telecommunications Rooms (TRs) as described by the drawings and also in the case any additional wiring is identified as necessary as a result of field conditions and approved by the Designer
 5. Work Area Distribution Subsystem: Patch cords, adapters, and devices located between the TO and station equipment. Complete work as shown in the drawings and as specified in Section 271600.
- C. The communications distribution system is based on a combination of, but not limited to, the following communications transmission technologies:
1. 100-ohm 4-pair unshielded twisted-pair cable. (Cat 6)
 2. 100-ohm multi-pair unshielded twisted-pair cable. (Cat 3)
 3. 8.3/125-micron single-mode fiber optic cable.
 4. 8-position telecommunications jacks.
 5. 8-position telecommunications patch panels
 6. Insulation displacement connector (IDC) type field terminated wiring blocks
 7. Outside plant copper splice enclosures
 8. Building entrance protection
 9. Factory Terminated copper patch cords
 10. Rack mount fiber optic hardware
 11. Wall mounted fiber optic hardware
 12. Fiber optic connectors & hardware
 13. Factory terminated fiber optic patch cords
 14. Outside plant fiber splice enclosures
- D. The work locations and limits of work are shown on the drawings.

1.07 DESIGN CRITERIA

- A. Compliance by the Contractor with the provisions of this specification does not relieve him of the responsibilities of furnishing materials and equipment of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.
- B. The following are incorporated into the design:
1. The communications room installations are designed to be as similar as possible.
 2. Electrical protection is provided for all exposed inter-building twisted-pair cabling.

3. The location of communication rooms is intended to restrict the maximum horizontal sub-system wiring length (defined as a channel between a telecommunications room cross-connect termination field and a served TO) to 295 feet (90 meters).

1.08 WARRANTY

- A. The Contractor shall provide a manufacturer's warranty on the horizontal and backbone systems as specified in Section 27 13 00 and 27 15 00.
- B. In addition to the standard warranty requirements, the Contractor shall provide the following during the warranty period:
 1. Within 24 hours after notification of a defect, the Contractor shall start to make the necessary corrections and inform the appropriate Project Manager of the planned corrective actions. The Contractor shall follow this initial contact with continuous effort and complete any required corrective work within 15 days after notification.

1.09 QUALIFICATIONS

- A. Communications Pathway Installation: The Contractor shall have 5 years of documented experience installing raceway and cable tray systems for each of the types and system material components specified in the Contract Documents, e.g., cable tray. In the case of newer technologies that do not have a 3-year history, the contractor shall have documented experience for at least half of the lifetime of the new technology.
- B. The Contractor selected for this project must be certified by the manufacturer of the products installed, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project.
- C. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.
- D. Company certificate & letter from manufacturer stating Contractor's certification is in good standing, shall be included with submittal.
- E. Certified Installer must register project with the specified cable manufacturers, as applicable, and must provide a warranty on the installation workmanship & testing for a length of no less than twenty (20) years.
- F. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical, Category 5e, Category 6 and Category 6a premise distribution systems and have personnel who are adequately trained in the use of such tools and equipment.
- G. A resume of qualification shall be submitted with the Contractor's proposal indicating the following:
 1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 2. A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.
 3. A technical resume of experience for the contractor's Project Manager and on-site installation supervisor who will be assigned to this project.

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4. A list of technical product training attended by the contractor's personnel that will install the structured cabling system shall be submitted with the response.
5. Any sub-contractors, who will assist the Contractor in performance of this work, shall have the same training and certification as the Contractor.

1.10 SUBMITTALS**A. General:**

1. Provide ongoing inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of same are clearly indicated and non-applicable portions clearly deleted or crossed out.
3. When the specifications include product descriptions, model numbers, part numbers, etc. that have been superseded, changed, or discontinued, the contractor shall submit a comparable substitution for review by the A/E.
4. The specified manufacturer's copper & fiber cable extended warranty program certificates stating that the communications installer is in good standing in applicable program.

B. Provide all applicable portions of the following information with the Bid:

1. Documentation establishing qualifications to perform installation functions as required in 1.9 above:
2. Statement demonstrating an understanding of project scope and schedule which includes the following information:
 - a) Where (city, office) the project will be staffed.
 - b) Project organizational chart with team names; e.g., project manager, A/Es, principal skilled technicians, and contractors.

C. Provide all applicable portions of the following information within 10 days after award:

1. Project schedule in hard copy. Include, at a minimum, major tasks, milestones, dependencies, staffing, and durations for each task.
2. Contractor shall then work with contractor to merge this schedule into the overall construction schedule.
3. Provide the following information for materials, components, and equipment to be furnished by the contractor:
 - a) Descriptive literature, manufacturer's specification data sheets, and manuals.
 - b) Individual price and delivery schedules.
 - c) Manufacturer's product test data with indicator arrows. The submittal shall be in the same order as products in 27 11 00, 27 13 00 and 271600.
 - d) Final Performance testing criteria and data for communications distribution system cabling systems.

1.11 DEFINITION OF ACCEPTANCE

- A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:
 - 1. All submittals and documentation have been submitted, reviewed, and approved.
 - 2. The complete system has successfully completed all testing requirements.
 - 3. All Owner staff personnel training programs have been completed.
 - 4. All punch list items have been corrected and accepted.
 - 5. Project registration for warranty by manufacturer.

1.12 PROJECT RECORD DOCUMENTS

- A. Provide detailed project record documentation within 30 days after completion of the work.
 - 1. Maintain separate sets of red-lined record drawings for the communications work which show the exact placement and identification of as-built system components.
 - 2. Provide communication pathway record drawings which indicate exact placement and routing for all components, e.g., maintenance holes, handholes, conduit, wireway, cable tray, pull boxes, enclosures, telecommunications outlet boxes, etc.
 - 3. Provide communication room record drawings which indicate exact placement for all components; e.g., conduit, wireway, cable tray, backboards, equipment cabinets, equipment racks, cross-connect equipment, etc.
 - 4. Provide communication wiring and cabling record "As-Builds" drawings and schedules which indicate exact placement, cable foot marking, routing, and connection details for all components, e.g., twisted-pair and fiber optic cables, splices, cable cross-connect termination locations, enclosures, telecommunications outlets, cross-connect jumpers, patch cords, etc.
 - 5. Provide network schematics when appropriate.

PART 2 PRODUCTS

2.01 APPROVALS AND SUBSTITUTIONS

- A. Equivalent product(s) may be considered for substitution for those products specified, however, the equivalent product(s) must be approved and show demonstrated and documented equivalence to the product(s) specified. Documentation shall include, but is not limited to: product samples, data sheets, and actual test data. The request for product substitution, and supporting documentation, must be submitted, in writing, prior to submitting the bid. Written approval for product substitution must be submitted with the bid.

PART 3 EXECUTION

3.01 WORKMANSHIP

- A. Manufactured products, materials, equipment, and components shall be provided, conditioned, applied, installed, connected, and tested in accordance with the manufacturer's specifications and printed instructions
- B. The installation of all system components shall be carried out under the direction of qualified personnel. Appearance shall be considered as important as mechanical and electrical efficiency. Workmanship shall meet or exceed industry standards.

3.02 SERVICE CONTINUITY

- A. Maintain continuity of communications services to all functioning portions of the process or buildings during hours of normal use.
- B. Arrange temporary outages for cutover work with electrical contractor or general contractor. Keep outages to a minimum number and a minimum length of time in order to provide minimum impact.

3.03 LAYOUT AND TOLERANCES

- A. Follow as closely as practicable the design shown on the drawings. Make all necessary measurements in the field to verify exact locations and ensure precise location and fit of specified items in accordance with the drawings. Make no substantial alterations without prior approval of the Designer and the A/E.
- B. Perform all work to the lines, grades, and elevations indicated on the drawings. Provide experienced, competent personnel to locate and lay out the work and provide them with suitable tools, equipment, and other materials required to complete layout and measurement work. Use lasers or other approved methods to establish line and grade.

3.04 CONSTRUCTION REVIEW

- A. The A/E and the Designer will review and observe installation work to ensure compliance by the Contractor with requirements of the Contract Documents.
- B. The Contractor shall inspect and test completed communications installations to demonstrate specified performance levels including the following:
 - 1. Furnish all instruments and personnel required for the inspections and tests.
 - 2. Perform tests in the presence of the A/E and Designer.
 - 3. Demonstrate that the system components operate in accordance with the Contract Documents.
- C. Review, observation, assistance, and actions by the Architect/Engineer (A/E) or General Contractor (GC) shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The A/E's and General Contractor's review and observation activities shall not relieve the contractor from the responsibilities of these Contract Documents.
- D. The fact that the A/E, GC or the owner does not make early discovery of faulty or omitted work shall not bar the A/E, GC or the owner from subsequently rejecting this work and insisting that the contractor make the necessary corrections.
- E. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the A/E, GC or the Owner for an increase in the Subcontract price, or for any payment on account of increased cost, damage, or loss.

END OF SECTION

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SECTION 27 11 00
EQUIPMENT ROOM FITTINGS

PART 1 GENERAL**1.01 SUMMARY**

- A. The communications equipment room will be referred as Telecommunications Room (TR) in this document is intended to house racks, cabinets and equipment necessary for the support of the communications cabling infrastructure.

1.02 RELATED DOCUMENTS

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
 - 1. Contract Documents
 - 2. Division 00 – Procurement & contracting Requirements Group
 - 3. Division 1 – General Requirements
 - 4. Section 27 10 00 – Structured Cabling General Requirements
 - 5. Section 27 13 00 – Backbone Cabling
 - 6. Section 27 15 00 – Horizontal Cabling CAT 6

1.03 REFERENCES

- A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
- B. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
- C. TIA/EIA-568-B – Commercial Building Telecommunications Cabling Standard, current version.
- D. TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
- E. TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
- F. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
- G. IEEE 241 – IEEE Recommended Practice for Electric Power Systems in Commercial Buildings, pertaining to communication systems.
- H. TIA-310- D Cabinets, Rack, and Associated Equipment

1.04 WARRANTY

- A. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.

PART 2 PRODUCTS**2.01 APPROVALS AND SUBSTITUTIONS**

- A. All products shall be provided as specified, without exception, unless approved in writing prior to the bid. All products shall be "NEW".
- B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor.

2.02 TELECOMMUNICATIONS BACKBOARDS

- A. AC-rated plywood, fire-retardant treated, 3/4 inches by 48 inches by 96 inches (19 by 1220 by 2440 mm).

2.03 FREE STANDING 2 POST EQUIPMENT RACKS

- A. 7-foot-high, 19 inches wide, 6.5-inch channel depth, EIA free-standing rack, UL listed, black finish
 - 1. Ortronics Mighty Mo 6 OR-MM6706
 - 2. Refer to Drawings

2.04 EQUIPMENT ENCLOSURE (HALF RACK)

- A. EIA compliant 19" gangable equipment enclosure 25 rack units and 32 Inches Deep.
 - 1. Fully welded construction for strength
 - 2. Standard front and rear adjustable 10-32 threaded rackrail with numbered spaces
 - 3. Includes full ventilated front door and rear doors.
 - 4. Include solid top panel with side cable entry grommets.
 - 5. Include solid side panels
 - 6. Provide 4 castors to allow cabinet movement. Part No. CBS – BGR.
 - 7. Middle Atlantic BGR Series
 - a. Frame & Rear Door: BGR2532
 - b. Front Door: BVFD-25
 - c. Side Panels: BSPN-25-32
 - 8. Refer to Drawings

2.05 EQUIPMENT ENCLOSURES

- A. EIA compliant 19" gangable equipment enclosure 44 rack units and 33 Inches Deep.
 - 1. Fully welded construction for strength
 - 2. 24-1/4" overall width provides space for side cabling or cooling airflow
 - 3. Convenient lacing points and slotted rail brackets for cable management
 - 4. Standard front and rear adjustable 10-32 threaded rackrail with numbered spaces
 - 5. Extra-wide rackrail features cable pass-throughs to facilitate front-to-rear cabling
 - 6. Includes full profile mesh front door and rear doors.
 - 7. Include solid top panel with side cable entry grommets.
 - 8. Include solid side panels

9. Provide 4 castors to allow cabinet movement.
10. Legrand Part No. OR-442433-B
11. Refer to Drawings

2.06 WALL MOUNT CABINET

- A. EIA compliant 19" gangable equipment enclosure rack units shown on drawings
- B. 3 section wall cabinet (wall section, equipment section and lockable door.)
- C. Swing open center ventilated equipment section allows front and rear access
- D. Cabinet shall be 26" wide with integrated cable management.
- E. Usable equipment depth is 24"
 1. Middle Atlantic Products CWR –XX-26PD (XX = rack unit height shown on drawings)

2.07 VERTICAL WALL MOUNTED RACKS

- A. EIA compliant 19" gangable equipment enclosure rack units shown on drawings
- B. Cabinet shall have 4 rack units and 31 inches of vertical mounting depth.
- C. Legrand Model # VWMFD-4RU-36-B.
- D. Provide a Hoffman Model No. DAH2001A Aux. Cabinet Heater with Thermostat. Mount in lower section of vertical data cabinet.

2.08 VERTICAL WIRE MANAGERS

- A. 7-foot-high, 6 inches wide, 8 inches deep with dual-hinged door and integral one rack unit high horizontal management, black finish.
 1. Ortronics Mighty Mo 6 OR-MM6VMD706
 2. Provide as shown on Drawings.

2.09 HORIZONTAL WIRE MANAGERS

- A. 19 inches wide, two rack units high with cover, for copper management
 1. Ortronics Mighty Mo 6 OR-MM6HMF2RU
 2. Provide as shown on Drawings.
- B. 19 inches wide, one rack unit high with cover, for fiber management
 1. Corning CJP-01U
 2. Provide as shown on Drawings.

2.10 TELECOMMUNICATIONS GROUNDING BUSBAR

- A. Solid copper busbar kit, 12.0 inches long X 4.0-inch-wide, wall-mounted, with standoffs.
 1. Ortronics P/N WMBB-12
 2. Provide as shown on Drawings.

2.11 CABLE RUNWAY

- A. 12 inches wide, 10-foot lengths, steel construction, Telco Style.
- B. Cablofil 09-8104-0010-12
- C. Refer to Ortronics-Cablofil catalog for additional part numbers and accessories required proper installation of specified cable runway.

PART 3 EXECUTION**3.01 INSTALLATION PRACTICES**

- A. All materials shall be installed as per the manufacturers' instructions, unless noted otherwise.
- B. Furnish and install telecommunication backboards on wall of communication equipment rooms as indicated. The bottom of the backboards shall be placed approximately six inches above finished floor (AFF), and must extend to a minimum height AFF of eight feet. Mount backboards with the smooth side facing away from the wall, and paint the backboard with two coats of fire-resistant white paint prior to mounting. A minimum of six appropriate fasteners shall be used for every sixteen square feet of backboard.
- C. Free-standing equipment racks shall be fastened to the communications room floor using a minimum of four 3/8-inch concrete anchors.
- D. Equipment racks shall be positioned according to drawings with a minimum of 3 feet clearance in front and back. The contractor shall field verify the dimensions of the room prior to installation of racks and report any discrepancies to the owner or owner's representative.
- E. Vertical wire managers for free-standing racks shall be bolted to the side or front of the rack using the manufacturers recommended hardware.
- F. All equipment racks, cabinets, enclosures, cable tray, conduits, and patch panels shall be bonded to the Telecommunications Grounding Busbar (TMG) (one per Telecommunications Room), which shall be bonded to the Telecommunications Main Grounding Busbar (TMGB), which shall be grounded to the main electrical ground in the main electrical room. Coordinate with electrical contractor. Coordinate exact routing and connection points with the electrical work. All surfaces that are used as a bond shall be filed to bare metal before completing connections.
- G. Install cable tray as shown in drawing package. The locations shown may need to be adjusted slightly in the field to assure proper placement.
- H. All tray sections shall be field cut to length as required with a minimum number of splice points. All field cuts shall be made using the manufacturers recommended equipment.

3.02 LABELING

- A. Label all racks within the BEF, TR, and TE with a unique identifier beginning with the number one, i.e. TR1-1. (Coordinate with Designer)
- B. Label the telecommunications grounding busbar and bonding conductor within the BEF, TR, and TE with a unique identifier, beginning with the number one, i.e. TGB-TR-1. (Coordinate with Designer).
- C. Label all patch panels and wiring blocks within the BEF, TR, and TE with a number and a unique identifier, beginning with the AA, i.e. TR1-AA. (Coordinate with Designer)

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EQUIPMENT ROOM FITTINGS

PHASE 1: 2022 BOND

271100

END OF SECTION

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SECTION 27 15 00**COMMUNICATIONS HORIZONTAL CABLING****PART 1 - GENERAL****1.1 SUMMARY**

- A. The project includes the installation of new Cat. 6 cabling and associated components. The existing raceways and pathways will be utilized in most case and new raceways and pathways will be required in locations where cabling does not currently exist. Pathways and raceways may need to be modified to accommodate cable fill and bend requirements. Refer to drawing and related specifications sections for additional information.
- B. Horizontal (distribution) communications wiring and connecting hardware from the Telecommunications Room (MDF, IDF, TR) to Telecommunication Outlets / Network Jacks throughout the site.

1.2 RELATED DOCUMENTS

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
 - 1. Contract Documents
 - 2. Division 00 – Procurement & Contracting Requirements Group
 - 3. Division 1 – General Requirements
 - 4. Section 27 10 00 – Structured Cabling General Requirements
 - 5. Section 27 05 26 – Grounding and Bonding for Communications Systems
 - 6. Section 27 11 00 – Communications Equipment Room Fittings
 - 7. Section 27 17 01 – Testing, Identification and Administration for Category 6 Cables

1.3 REFERENCES

- A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
 - 1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
 - 2. TIA/EIA-568-B – Commercial Building Telecommunications Cabling Standard, current version.

3. TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
4. TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
6. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings” pertaining to communication systems.

1.4 SYSTEM DESCRIPTION

- A. The horizontal distribution subsystem refers to all intra-building twisted-pair and fiber optic communications cabling connecting Telecommunication Rooms (MDF, IDF, TR's) to telecommunication outlets / network jacks located at individual work areas.
- B. Horizontal cabling may consist of a combination of the following types of cable:
 1. Category 6, (100 Ohm, 23 Gauge AWG, 4-pair, unshielded twisted pair) cables.
- C. The Horizontal System includes cables, jacks, patch panels, connecting blocks, patch cords, fiber connectors and jumpers as well as the necessary support systems, such as cable managers and faceplates.
- D. Cables may be routed through conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above ceiling tile, and through plenum air-handling spaces above ceiling tile.
- E. Furnish and install all materials necessary for a complete and working system.

1.5 WARRANTY

- A. The contractor must be an approved certified installer of the cabling manufacturer and is responsible for workmanship and installation practices in accordance with the cabling manufacturer's guidelines. The certified contractor shall have 30% of their technicians trained on copper & fiber installations and testing by the cabling manufacturer. Provide a one (1) year warranty.

PART 2 - PRODUCTS

2.1 APPROVALS AND SUBSTITUTIONS

- A. All products shall be provided as specified, unless an approved equal is provided.

B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).

C. All products shall be "NEW".

2.2 CATEGORY 6 STATION CABLING

A. Category 6 unshielded twisted pair (**Superior Essex Data Gain**)

1. 100 ohm, Category 6+, 23AWG, 4-pair unshielded twisted pair, CMP rated,
 - a. Maximum insertion loss of 2.0 dB/100M at 1 MHz, 19.7 dB/100M at 100 MHz, 32.6 dB/100M at 250 MHz and 42.7 dB/100M at 400 MHz.
 - b. Electrical characteristics must be characterized to 550 MHz.
 - c. Each pair in the cable must be insulated with FEP
 - d. Cable must be third party verified by ETL.
 - e. 0.22" (5.5mm) Nominal Diameter
 - f. Refer to Color Coding for various systems and applications

2.3 MODULAR JACKS

A. Category 6 modular jacks

1. 8-position modular jack, Category 6, IDC terminals, T568A/B wiring scheme
2. Each jack must be stamped or have icons to identify it as CAT 6.
3. Panduit NetKey Part # NK688M*. Color - Refer to Color Coding for various systems and applications.

2.4 FIELD TERMINATABLE RJ-45 JACKS:

A. Category 6 modular jacks

1. 8-position modular jack, Category 6, IDC terminals, T568A/B wiring scheme
2. Terminates 22-26AWG Solid Conductors
3. Legrand Part # FTPUC65E – 5 pk
4. Install on end of Cat 6 cables supporting Electronic Devices and IP Classroom Modules.
5. Provide Cable Labels on new cables within 3 inches of jack.

2.5 WORK AREA OUTLETS

A. Face Plates:

1. One port wall telephone faceplate with mounting lugs for wall phone, constructed from stainless steel, mounts within a single gang wall box.
 - a. Panduit Part No. KWPY.

2. One port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single gang wall box.
 - a. Panduit NetKey Part No. NK1FIWY.
3. Two port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single gang wall box.
 - a. Panduit NetKey Part No. NK2FIWY.
4. Four port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single gang wall box.
 - a. Panduit NetKey Part No. NK4FIWY.
5. Six port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single gang wall box.
 - a. Panduit NetKey Part No. NK6FIWY.
6. All faceplate colors are to be coordinated with architect to match finish.

B. Surface mounted outlet boxes:

1. Two port surface mount box, constructed from high impact thermo-plastic, with recessed label fields, rated for plenum spaces.
 - a. Panduit NetKey Part No. NK2BXIW-AY.
2. Four port surface mount box, constructed from high impact thermo-plastic, with recessed label fields.
 - a. Panduit NetKey Part No. NK4BXIW-AY.
3. Six port surface mount box, constructed from high impact thermo-plastic, with recessed label fields.
 - a. Panduit NetKey Part No. NK6BXIW-AY.

2.6 TERMINATION BLOCKS

A. Category 6 110-style blocks

1. Category 6, 288 Pair, 110-style, with mounting legs, wall -mount.
 - a. Ortronics OR-110ABC6300.
2. Category 6, 96 Pair, 110-style, with mounting legs, wall -mount.
 - a. Ortronics OR-110ABC6100.
3. Category 6, 288 Pair, 110-style, without mounting legs, rack-mount.
 - a. Ortronics OR-110DBC6300.

4. Category 6, 96 Pair, 110-style, without mounting legs, rack-mount.

a. Ortronics OR-110DBC6100.

B. Wiring Troughs

1. Horizontal trough for routing of patch cords and cross-connect wire, with mounting legs.

a. Ortronics OR-30200140.

2. Horizontal trough for routing of patch cords and cross-connect wire, without mounting legs.

a. Ortronics OR-70400272.

C. 110 block labels (Cat 6)

1. Clear plastic holder for 110 blocks with paper inserts, for blocks with legs

a. Ortronics OR-70400646.

2. Clear plastic holder for 110 blocks with paper inserts, for blocks without legs

a. Ortronics OR-70400680.

D. Mounting Brackets

1. 19 inch rack mount brackets for 200 pair 110 termination blocks and wiring troughs.

a. Ortronics OR-30600150.

2.7 PATCH PANELS**A. Category 6 modular patch panels**

1. 24 port, 8-position modular jack flat panel, high density, 6 port modules, Category 6, IDC terminals, T568A/B wiring scheme.
 - a. Panduit NetKey – Part #NKPP24FMY

2.8 COLOR CODING

1. Various systems in the facilities have color coded network cabling, jacks and patch cables. Maintain this color coding for all of the new network cabling, jacks and patch cables.
 - a. Yellow: Standard in wall desk jacks, this would also be used for Printers, Copiers, Projectors and Displays
 - b. Purple / Violet: Sound & Lockdown System
 - c. Green: Wireless Access Point
 - d. Blue: IP Telephones
 - e. ORANGE: IP Cameras
 - f. White: VAP Detectors
 - g. Pink: Door Access Control (IP Control Panels above doors)
 - h. BEIGE: Analog Telephone / Fax Lines

2.9 PATCH CORDS/JUMPERS

1. Category 6 modular patch cords (Legrand Q-Series)
2. Factory terminated double ended, 8-position to 8-position, modular, stranded conductors, Category 6, 4 pair, 28 gauge, Legrand #576-RDXX-00X.
3. Color: Refer to Color Coding for various systems and applications.
4. Provide the following quantities and lengths for use to interconnect horizontal cabling to the Network Switches in telecom closets:
 - a. (500) 1 foot patch cables – Yellow for Standard wall jacks
 - b. (50) 1 foot patch cables – Blue for IP Telephones
 - c. (50) 1 foot Patch Cables – Green for WAP's
 - d. (50) 1 Foot Patch Cables – ORANGE for IP Cameras
5. Confirm Patch Cable colors and lengths with Owner prior to ordering.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Horizontal cabling includes cables, jacks, patch panels, connecting blocks, and patch cords, as well as the necessary support systems, such as cable managers and faceplates.
- B. Contractor shall furnish and install all materials necessary for a complete and working system.
- C. Contractor must be a certified manufacturer installer prior to, during, and through completion of the system installation.
- D. Field terminated copper and fiber optic patch cords and jumpers shall not be allowed. All patch cords shall be pre-terminated by the manufacturer.
- E. All work shall be performed in a professional manner.
- F. Install cable after interior of building has been physically protected from the weather and all mechanical work likely to damage cabling has been completed.
- G. Before installing cabling, ensure all cable pathways are completely and thoroughly cleaned:
- H. Inspect conduit, wireway, cable trays, and innerduct installed by others.
- I. Clean any additional enclosed raceway and innerduct systems furnished.
- J. Provide protection for exposed cables where subject to damage.
- K. Provide abrasion protection for any cable or wire bundles, which pass through holes or across edges of sheet metal. Protective bushings shall be used to protect cables.
- L. Cable ties and other cable management clamps shall be no more than hand tightened and shall fit snugly, but not compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices. Plenum spaces require Plenum rated cable ties.
- M. Where possible, route cables in overhead cable trays and inside wire management systems attached to the equipment cabinets and racks. Use plastic ties or ducts to restrain cabling

installed outside of wire management systems on racks or in cabinets. Cable trays shall not exceed 50% fill.

- N. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- O. Cable raceways shall not be filled greater than the TIA/EIA-569-A maximum fill for the particular raceway type.
- P. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids, plumbing pipes, and electrical conduits.
- Q. Horizontal distribution cables shall be bundled in groups of no more than the amount of cables designed for by the cable support manufacturer recommends based on cable OD and weight. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- R. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
- S. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- T. All Conduit Sleeves and wire way trays penetrating fire walls shall have 3M Fire Barrier Pillows installed. Contractor is responsible to place fire barrier pillows on all existing penetrations that will be reused to run new cable and all new penetrations required for the new cable installation. Fire barrier Pillows shall be placed per manufacturer's recommendation to create a 2 hour fire barrier.

3.2 UNSHIELDED TWISTED PAIR CABLE INSTALLATION PRACTICES

- A. Cable shall be installed in accordance with manufacturer recommendations and best industry practices.
- B. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- C. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

- D. The cable's minimum bend radius and maximum pulling tension shall not be exceeded Bend radius for UTP = 4 X Cable OD, FTP = 8 X Cable OD.
- E. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- F. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable. Separation from Power Lines:
- G. Provide the following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
 - 1. Open or Nonmetal Communications Pathways:
 - a. 12 inches from electric motors, fluorescent light fixtures, and unshielded power lines carrying up to 3 kVA.
 - b. 36 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
 - c. 48 inches from large electrical motors or transformers.
 - 2. Grounded Metal Conduit Communications Pathways:
 - a. 2 1/2 inches from electrical equipment and unshielded power lines carrying up to 2 kVA.
 - b. 6 inches from electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA.
 - c. 12 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
 - d. 3 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA.
 - e. 6 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying more than 5 kVA.

3.3 UNSHIELDED TWISTED PAIR TERMINATION

- A. Cables shall be coiled to house the cable coil without exceeding the manufacturers bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored; Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
- B. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B.1 document, manufacturer's recommendations and best industry practices.

- C. All 4 pair cables shall be terminated on the jack and patch panels using T568-B wiring scheme.
- D. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- E. Bend radius of the horizontal cable shall not be less than 4 times the outside diameter of the UTP cable. 8 times for FTP cables.
- F. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- G. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- H. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- I. The cable jacket shall be maintained as close as possible to the termination point. Cable shall not have more than 1.0" removed.

3.4 TESTING AND LABELING PROCEDURES

- A. Refer to Specifications Section 271701 – Testing, Identification and Administration for Category 6 Cable.
- B. All horizontal cables are to be labeled using a machine printed label at each end of the cable at approximately 12 inches of the termination point, and again at approximately 48 inches from the termination point. Handwritten labels shall not be used.
- C. All patch panel ports and telecommunication outlet ports shall be labeled with the cable identifier.
- D. The labels shall denote the Telecommunications outlet ID, as well as the unique cable number for that Telecom Outlet, i.e. A-001-A for cable number 1, A-001-B for cable number 2, and so forth. Owner may provide specific labeling requirements coordinate with owner.
- E. Note all labeling information on the as-built drawings.

END OF SECTION

SECTION 27 17 01**TESTING, IDENTIFICATION AND ADMINISTRATION OF CATEGORY 6 CABLE****PART 1 - GENERAL****1.01 WORK INCLUDED**

- A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.
- B. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- C. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.

1.02 SCOPE

- A. This Section includes the minimum requirements for the test certification, identification and administration of horizontal balanced twisted pair cabling.
- B. This Section includes minimum requirements for:
 - 1. Copper cabling test instruments
 - 2. Copper cabling testing
 - 3. Identification
 - a) Labels and labeling
 - 4. Administration
 - a) Test results documentation
 - b) As-built drawings
- C. Testing shall be carried out in accordance with this document.
- D. Testing shall be performed on each cabling link. (100% testing)
- E. All tests shall be documented and submitted to Owner for review

1.03 QUALITY ASSURANCE

- A. All testing procedures and field-test instruments shall comply with applicable requirements of:
 - 1. ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - 2. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
 - 3. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard
 - 4. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
 - 5. ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.

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- B. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - 1. Manufacturer of the connectors or cable.
 - 2. Manufacturer of the test equipment used for the field certification.
 - 3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)
- C. The Owner or the Owner's representative shall be invited to witness and/or review field-testing.
 - 1. The Owner or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.
 - 2. The Owner or the Owner's representative will select a random sample of 5% of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the Owner.

1.04 SUBMITTALS

- A. Manufacturers catalog sheets and specifications for the test equipment.
- B. A schedule (list) of all balanced twisted-pair copper links to be tested.
- C. Sample test reports.

1.05 ACCEPTANCE OF TEST RESULTS

- A. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in tested for:
 - 1. Wire Map
 - 2. Length
 - 3. Propagation Delay
 - 4. Delay Skew
 - 5. DC Loop Resistance – recorded for information only
 - 6. DC Resistance Unbalance – recorded for information only
 - 7. Insertion Loss
 - 8. NEXT (Near-End Crosstalk)
 - 9. PS NEXT (Power Sum Near-End Crosstalk)
 - 10. ACR-N (Attenuation to Crosstalk Ratio Near-End) – recorded for information only
 - 11. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for information only
 - 12. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - 13. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - 14. Return Loss

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15. TCL (Transverse Conversion Loss) – recorded for information only
 16. ELTCTL (Equal Level Transverse Conversion Transfer Loss) – recorded for information only
 17. PS ANEXT (Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
 18. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
 19. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2
 20. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2
- B. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described in Part 3. Any Permanent Link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation in accordance with Part 3.
- C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

PART 2 - PRODUCTS**2.01 BALANCED TWISTED-PAIR CABLE TESTERS**

- A. The field-test instrument shall be within the calibration period recommended by the manufacturer, typically 12 months.
- B. Certification tester
1. Accuracy
 - a) Level III accuracy in accordance with ANSI/TIA-1152
 - b) Independent verification of accuracy
 - c) Acceptable manufacturers
 - 1) Fluke Networks
 2. Permanent Link Adapters
 - a) RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
 - b) Twisted pair Category 5e, 6, 6A, 7 or 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures
 3. Results Storage
 - a) Must be capable of storing > 10,000 results for all measurements found in 2.1.B.4 below
 4. Measurement capabilities
 - a) Wire Map
 - b) Length
 - c) Propagation Delay

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- d) Delay Skew
 - e) DC Loop Resistance
 - f) DC Resistance Unbalance
 - g) Insertion Loss
 - h) NEXT (Near-End Crosstalk)
 - i) PS NEXT (Power Sum Near-End Crosstalk)
 - j) ACR-N (Attenuation to Crosstalk Ratio Near-End)
 - k) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 - l) ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - m) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - n) Return Loss
 - o) TCL (Transverse Conversion Loss)
 - p) ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - q) Time Domain Reflectometer
 - r) Time Domain Xtalk Analyzer
 - s) PS ANEXT (Power Sum Alien Near-End Crosstalk)
 - t) Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
 - u) PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
 - v) Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
- C. PC Software
- 1. Windows® based.
 - 2. Must show when 3 dB and 4 dB rules are applied
 - 3. Re-certification capability, where results must have their Cable IDs suffixed with (RC).
 - 4. Built in PDF export – no additional third party software permitted.
 - 5. Built-in statistical analysis.

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2.02 IDENTIFICATION**A. Labels**

1. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
2. Shall be preprinted using a mechanical means of printing (e.g., laser printer).
3. Where used for cable marking, provide vinyl substrate with a white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.
4. Where insert type labels are used provide clear plastic cover over label.
5. Provide plastic warning tape 6 inches wide continuously printed and bright colored 18" above all direct buried services, underground conduits and duct-banks.
6. Acceptable Manufacturers:
 - a) Brady Corporation
 - b) Silver Fox
 - c) Brothers

2.03 ADMINISTRATION

- A. Administration of the documentation shall include test results of each Permanent Link.
- B. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- C. The test result records saved within the field-test instrument shall be transferred into a Windows® - based database utility that allows for the maintenance, inspection and archiving of these test records.
- D. Alien Crosstalk measurements shall be stored to a PC upon completion of the test.

PART 3 – EXECUTION**3.01 GENERAL**

- A. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

3.02 BALANCED TWISTED PAIR CABLE TESTING

- A. Field-test instruments shall have the latest software and firmware installed.
- B. Permanent Link test results including the individual frequency measurements from the tester shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- C. Permanent Link testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.
- D. Alien Crosstalk testing shall be performed using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859-1 for populations of up to 500,000 links shall be used. The following table represents this sampling level.

Installation size (No. of total links)	Sample size (No. of links to test)
3 – 33	100%
34 – 3,200	33
3,201 – 35,000	126
35,001 – 150,000	201
150,001 – 500,000	315

Disturbed (Victim) links chosen for Alien Crosstalk testing shall be an equal combination of short, medium and long links.

- E. Permanent Link adapters made from twisted pair Category 5e, 6, 6A, 7 or 7_A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- F. The installer shall build a reference link. All components shall be anchored so it is not possible to disturb them. The technician is to conduct a Category 6A Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.
- G. Wire Map Measurement
 - 1. The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For each of the 8 conductors in the cabling, the wire map indicates:
 - a) Continuity to the remote end
 - b) Shorts between any two or more conductors
 - c) Reversed pairs
 - d) Split pairs
 - e) Transposed pairs
 - f) Distance to open on shield

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- g) Any other miss-wiring
 - 2. The correct connectivity of telecommunications outlets/connectors is defined in ANSI/TIA-568-C.2. Two color schemes are permitted. The user shall define which scheme is to be used. The field tester shall document which color scheme was used.
- H. Length Measurement
- 1. The length of each balanced twisted pair shall be recorded.
 - 2. Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay shall be reported and used for making the pass or fail determination.
 - 3. The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in ANSI/TIA-568-C.2 plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 325 ft. (99 m) before a fail is reported.
- I. Propagation Delay measurement
- 1. Is the time it takes for a signal to reach the end of the link.
 - 2. The measurement shall be made at 10 MHz per ANSI/TIA-1152.
 - 3. The propagation delay of each balanced twisted pair shall be recorded.
 - 4. Is not to exceed 498 ns per ANSI/TIA-568-C.2 Section 6.3.18.
- J. Delay Skew measurement
- 1. Is the difference in propagation delay @ 10 MHz between the shortest delay and the delays of the other wire pairs.
 - 2. The delay skew of each balanced twisted pair shall be recorded.
 - 3. Is not to exceed 44 ns per ANSI/TIA-568-C.2 Section 6.3.19.
- K. DC Resistance
- 1. Often reported as Resistance, is the loop resistance of both conductors in the pair.
 - 2. Is not specified in ANSI/TIA-1152, but shall be recorded for all four pairs.
- L. DC Resistance Unbalance
- 1. Often reported as Resistance Unbalance, is the difference in resistance of the two wires within the pair.
 - 2. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all four pairs.
- M. Insertion Loss
- 1. Is the loss of signal strength over the cabling (in dB).
 - 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz

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3. Worst case shall be reported for all four pairs in one direction only.
4. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.7.

N. NEXT (Near-End Crosstalk)

1. Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Shall be measured in both directions. (12 pair to pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.8.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
7. The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.

O. PS NEXT (Power Sum Near-End Crosstalk)

1. Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Shall be measured in both directions. (8 pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.9.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
7. The Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.

P. ACR-N (Attenuation Crosstalk Ratio Near-End)

1. Is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz

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- b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
 - 3. Shall be calculated in both directions.
 - 4. Is not specified in ANSI/TIA-1152, but shall be recorded for all 12 possible combinations.
- Q. PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End)
- 1. Is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
 - 3. Shall be calculated in both directions.
 - 4. Is not specified in ANSI/TIA-1152, but shall be recorded for all 8 possible combinations.
- R. ACR-F (Attenuation Crosstalk Ratio Far-End)
- 1. Is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions. (24 pair to pair possible combinations)
 - 4. Both worst case and worst margins shall be reported.
 - 5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.11.
 - 6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
- S. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
- 1. Is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.
 - 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions. (8 pair possible combinations)

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4. Both worst case and worst margins shall be reported.
5. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.13.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).

T. Return Loss

1. Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Shall be measured in both directions. (8 pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.6.
7. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
8. The Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.

U. TCL (Transverse Conversion Loss)

1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
3. Shall be measured in both directions.
4. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all 8 possible combinations.

V. ELTCTL (Equal Level Transverse Conversion Transfer Loss)

1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz

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- c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
 - 3. Shall be measured in both directions.
 - 4. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all 8 possible combinations.
- W. PS ANEXT (Power Sum Alien Near-End Crosstalk)
- 1. Takes into account the combined alien crosstalk (statistical) on a receive pair from all external near-end disturbers operating simultaneously.
 - 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
 - 3. The disturbed (victim) link shall have links to the left and right of it and if present, links above and below it.
 - 4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
 - 5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
 - 6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.21.
- X. Average PS ANEXT (Power Sum Alien Near-End Crosstalk)
- 1. Is calculated by averaging the individual PSANEXT loss values, in dB, for all four pairs in the disturbed (victim) link.
 - 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
 - 3. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.22.
- Y. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
- 1. AFEXT loss is the coupling of crosstalk at the far-end from external link pairs into a disturbed (victim) pair of the 4-pair link under test. PS AACR-F is the calculated power sum from all external pairs into the disturbed (victim) pair.
 - 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz

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- d) 250 – 500 MHz: 1000 kHz
- 3. The disturbed (victim) link shall have links to the left and right of it and if present, links above and below it.
- 4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
- 5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
- 6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.25.
- Z. Average PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
 - 1. Is calculated by averaging the individual PS AACR-F values, in dB, for all four pairs in the disturbed (victim) link.
 - 2. The frequency resolution shall be:
 - a) 1 – 31.25 MHz: 150 kHz
 - b) 31.25 – 100 MHz: 250 kHz
 - c) 100 – 250 MHz: 500 kHz
 - d) 250 – 500 MHz: 1000 kHz
 - 3. The disturbed (victim) link shall have links to the left and right of it and if present, links above and below it.
 - 4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
 - 5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
 - 6. Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.26.

3.03 ADMINISTRATION**A. Test results documentation**

- 1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”. The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
- 2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period and shall be passed to the Owner’s representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
- 3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD or DVD prior to Owner acceptance of the building. This CD or DVD shall include the software tools required to view, inspect, and print any selection of the test reports.
- 4. Circuit IDs reported by the test instrument should match the specified label ID
- 5. For Permanent Link testing, the detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and shall contain the following information

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- a) The overall Pass/Fail evaluation of the link-under-test
 - b) The date and time the test results were saved in the memory of the tester
 - c) The identification of the customer site as specified by the end-user
 - d) The name of the test limit selected to execute the stored test results
 - e) The name of the personnel performing the test
 - f) The version of the test software and the version of the test limit database held within the test instrument
 - g) The manufacturer, model and serial number of the field-test instrument
 - h) The adapters used
 - i) The factory calibration date
 - j) Wire Map
 - k) Propagation Delay values, for all four pairs
 - l) Delay Skew values, for all four pairs
 - m) DC Resistance values, for all four pairs
 - n) DC Resistance Unbalance, values for all four pairs
 - o) Insertion Loss, worst case values for all four pairs
 - p) NEXT, worst case margin and worst case values, both directions
 - q) PS NEXT, worst case margin and worst case values, both directions
 - r) ACR-F, worst case margin and worst case values, both directions
 - s) PS ACR-F, worst case margin and worst case values, both directions
 - t) Return Loss, worst case margin and worst case values, both directions
 - u) TCL, worst case values both directions
 - v) ELTCTL, worst case values, both directions.
 - w) Time Domain Crosstalk data if the link is marginal or fails
 - x) Time Domain Reflectometer data if the link is marginal or fails
6. For Alien Crosstalk testing, the detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and shall contain the following information
- a) The overall Pass/Fail evaluation of the link-under-test
 - b) The date and time the measurements were made
 - c) The identification of the customer site as specified by the end-user
 - d) The name of the test limit selected to execute the stored test results
 - e) The name of the personnel performing the test
 - f) The version of the test software
 - g) PS ANEXT, worst case margin for all four pairs
 - h) Average PS ANEXT, worst case margin

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- i) PS AACR-F, worst case margin for all four pairs
 - j) Average PS AACR-F, worst case margin
- B. Record copy and as-built drawings
1. Provide record copy drawings periodically through out the project as requested by the Construction Manager or Owner, and at end of the project on a CD or DVD. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:
 - a) Field directed changes to pull schedule.
 - b) Horizontal cable routing changes.
 - c) Associated detail drawings.

END OF SECTION

SECTION 27 50 10**SOUND SYSTEM & EMERGENCY NOTIFICATION SYSTEM****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. The drawings and general provisions of the Contract Documents apply to this Section.

1.02 SUMMARY

- A. Facilities included for removal of existing Sound System and Clock System and the installation of a new sound system, emergency displays and automated lockdown notification system are:
1. Cottage Lane Elementary School
 2. William Schaefer Elementary School
- B. This project includes but is not limited to the following:
1. Refer to project Milestone Schedule. Milestone #1 shall be to install the Rauland Tele-center System headend to provide automated Lockdown features at both schools. The existing Rauland sound systems will be utilized to broadcast emergency lockdown announcements.
 2. Remove existing Sound System / Public Address system including but not limited to main control rack, wiring, speakers, horns and associated equipment.
 3. Removal of old clock systems.
 4. Removal of wireless under desk panic buttons that operate on wireless transmitters that are part of an Intrusion Detection System. The Wireless Panic Buttons, associated transmitters and Intrusion Detection Panel is then interconnected to the Fire Alarm System's Cellular Dialer and reports out to the Monitoring Agency as a separate Lockdown Alarm. Remove the Wireless Panic Buttons, associated transmitters and Intrusion Detection Panel and wiring back to the FA Panel. Listed below are the number of devices to be removed:
Cottage Lane ES: Eight wireless under desk panic buttons, two transmitters, one intrusion detection panel.
Wm Schaefer ES: Five wireless under desk panic buttons, one transmitter, one intrusion detection panel.
 5. Provide a new Rauland Telecenter Universe Hybrid IP Sound System and Electronic Displays.
 6. Interface to existing local sound systems in Gyms, Cafeterias, Auditoriums, Multi-purpose Rooms, etc. to override local programming and local speakers to allow for All-Call Paging to be announced. Refer to drawings for local sound system locations.
- C. This section includes a fully operational school internal communications and clock incorporating safety including but not limited to the following:
1. The system shall provide complete internal communications and clock control employing state of the art VoIP Technology including the minimum functions listed.
 - a) Two-way Loud Speaking Internal Intercommunications.
 - b) Event announcement

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- c) Emergency announcement that will override any pre-programmed zones assuring that all Emergency/Lockdown etc., are heard at each and every speaker location.
 - d) Capability of prerecording emergency announcements that can simply be activated by a simple Soft Key or via a dedicated call-switch.
 - e) School Safety Paging and Evacuation tones,
 - f) Distributed (MDF/IDF) Electronic Architecture. (No home run wiring for each circuit).
 - g) Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone,
 - h) Paging and Program Distribution.
 - i) Incorporate district-wide announcements, either live or recorded thru a direct connection to the WAN and telephone system.
 - j) Synchronous analog clock and time control
 - k) Class change signaling
 - l) Atomic Clock Synchronization
 - m) Interface control with Master Clock System.
- D. Any authorized administrator shall be able to call from outside the school into any classroom; zone or entire school directly via the School District supplied Telephone Network. This shall allow remote monitoring and two-way conversation from outside the school building as well as Paging into the system. This feature shall allow the user access to all functions via a user defined PIN code. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools)
- E. Authorized system users shall be able to record a minimum of ten (10) automated messages with emergency instructions and replay them. Automated message strings shall be either automatically distributed as part of a dial string, manually played from a single-button access on the phone or thru the master clock as a timed event.
- F. Paging and two-way loud speaking features shall be accessible from any telephone by authorized users with the use of a user defined PIN code.
- G. The system shall allow users to exclude their classroom from paging and tones in the event of testing or other activity that shouldn't be interrupted. This exclusion will not affect emergency paging. This "exclusion" must have the ability to "reset" at midnight.
- H. The system shall synchronize its system time to the network timeserver or a web-based time server.
- I. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system.
- J. The system shall incorporate Rauland "Universe" functionality to permit control of Public Address functions from an internet browser. The Universe system shall also permit access to other building's P.A. systems once the software has been purchased and installed in those buildings or the district has obtained a district-wide Universe server license. All browser-based access shall be secured by passwords.

1.03 SUBMITTALS

- A. Product data for each component.

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- B. Shop Drawings: Prior to proceeding with the work: Provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection, and a complete schedule of all equipment and materials with associated manufacturers cuts sheets which are to be used.
1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.
 2. Drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.
 3. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor's name in the title block.
 4. Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.
- C. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems, which are not FCC approved or utilize an intermediary device for connection, will not be considered. Provide the FCC registration number of the system being proposed as part of the submittal process.
- D. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.
- E. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
- F. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.
- G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- H. Maintenance Data: For equipment to be included in maintenance manuals specified in Division
1. Record of Owners equipment-programming option decisions.
 2. All instructions necessary for proper operation and manufacturer's instructions.
 3. "Proof of Performance" information.
 4. Manufacturer's maintenance information.
 5. Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.
- I. Record Drawings: Prior to final acceptance, provide two complete sets of drawings indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions. These Record Drawings will be used during "Final Acceptance Testing".
- J. System Training: Submit the following information describing the training programs and system trainers.
1. Include with the submittal a preliminary staff development training program in outline form for review and approval by the owner's representative.

2. Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the project.
 3. Include with the submittal a current copy of trainer's need's assessment form which will be reviewed with the owner's designated representative for the system's preliminary system programming and configuration.
 4. Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.
- K. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required **five-year** equipment warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following within thirty (30) days after notification to proceed:
 1. Adequate plant and equipment to pursue the work properly and expeditiously.
 2. Adequate staff and technical experience to implement the work.
 3. Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.
- D. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of a "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/ Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer
- E. Each major component of equipment shall have the manufacturer's name, address and model number on a plate securely affixed in a conspicuous place. NEMA code ratings, UL Label, or other data that is die-stamped into the surface of the equipment shall be easily visible.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- G. Comply with NFPA 70
- H. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.
- I. Comply with UL 60950.

1.05 IN-SERVICE TRAINING

- A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions

- B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.
- C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

1.06 WARRANTY

- A. Provide a manufacturer's five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic equipment, as well as speakers. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one-year warranty shall be provided for labor.
- B. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality.
- C. During the first year of warranty, which includes material & labor, the Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.
- D. Make available a service contract offering continuing factory authorized service of the system after the initial one-year material & labor warranty period.

1.07 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide the following system:
 - 1. Telecenter "U" (Universe) manufactured by Rauland-Borg Corp.

PART 2 PRODUCTS

2.01 SYSTEM REQUIREMENTS

- A. The system shall utilize state of the art VoIP Technology, Call-in Notification, School Safety Paging and Evacuation tones, Distributed (MDF/IDF) Electronic Architecture, Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone, Two-way Loud Speaking Internal Intercommunications and Paging, and Program Distribution. The system shall be easy to learn and operate. All standard system programming shall be user friendly to allow the system administrator the ability to easily program system features.
- B. Provide complete and satisfactorily operating school communications and school safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

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- C. The system shall be a single electronic system consisting of amplified intercom channels depending upon the configuration of the system, (classroom) speakers, corridor speakers, inside and outside horns and master clock.
- D. Features offered by this system shall be implemented and controlled by a software program that can be changed and expanded as customer needs evolve.
- E. The system shall lend itself to expansion by simple addition of hardware modules.
- F. The system shall allow the implementation of bell schedules that are managed via the WAN/LAN. The system shall directly connect to the WAN/LAN without the need for a separate computer at the school location. Bell schedules can remotely be created, changed, stored and downloaded to the system by an authorized user from a browser-based interface.
- G. The system shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone within the facility or outside the facility to any other location within the facility. The system must also allow the implementation of a district-wide announcement system where live messages, pre-recorded announcements and emergency tones can be triggered via a telephone or browser-based user interface.
- H. The system shall have the capability for "panic button" response to an emergency situation. The "panic button" shall be able to be programmed to play a pre-recorded message, send text and email notifications, and initiate a contact-closure-based interface to a security company, fire department, etc. It shall also have the capability to interface with a card access system and/or a CCTV system.
- I. The system shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within the facility or outside the facility to any other location within the facility; all communication within the classroom shall be hands free and will not require any interaction by the end-user to answer.
- J. Room speakers shall be programmable and may be assigned any two, three, four or five digit number. Any extension may be reassigned at any time, and it shall not be dependent on wiring or circuit numbers.
- K. Amplified two-way voice communication shall be available from any provided telephone through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. 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 speaker monitoring is active, complying fully with all privacy legislation.
- L. Integrated Master Clock with unlimited schedules, unlimited events, and automatic Daylight Savings time correct. Up to 5 schedules may be active on any given day. User shall be able to select from 16 tone options or user created .wav files for class change signaling. In addition, the system shall allow unlimited user defined class change tones to be recorded. The system shall allow control of the bell schedules via the district WAN/LAN. The system shall directly connect to the WAN/LAN without the need for a separate computer at the school location. Bell schedules can remotely be created, changed, stored and downloaded to the system by an authorized user from a browser-based interface.
- M. "Universe" functionality for browser-based access and control of P.A. system.
- N. The District has previously installed Rauland Telecenter Sound & Lockdown Systems in South Orangetown Middle School and Tappan Zee High School. Program all four Rauland Telecenter Systems so that a District Wide Lockdown can be achieved.

2.02 EQUIPMENT AND MATERIAL

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- A. VoIP Based Controller (Gateway) Rauland-Borg Telecenter Series – with the following features and capabilities:
1. The ability to network multiple controllers via the LAN to provide a single interconnected system within the facility. The networking capability must provide for total transparency between controllers and in turn operate as a single system.
 2. On-site or off-site diagnostics shall be capable via a standard Ethernet port for factory-trained personnel. The controllers shall tie directly into the LAN. In addition, all bell scheduling tasks must be browser based allowing authorized access from off-site district staff. On-site facility staff may also perform these tasks in the same manner as the district staff.
 3. System shall connect to the district provided Telephone Network via an analog trunk, or station port.
 4. The VX Works based Operating System and system programming database shall be stored in non-volatile flash memory. The Operating System can be easily upgraded through a configuration program without requiring replacement of any chips. The system programming database can be easily archived.
 5. Support a flexible numbering plan allowing two, three, four, or five digit extensions. The two, three, four, and/or five digit extensions can be intermixed within the same facility. Each extension can include leading or trailing alpha digits to match a facility's room numbering scheme.
 6. Multiple attendant positions via district provided Telephone Network shall be capable of answering internal intercom call-ins a minimum of one (1) Marquee Display shall be provided.
 7. Personal Identification Numbers (PIN's) shall be available for all staff. By dialing their PIN at any provided telephone, the staff member shall have access to the School Internal Intercom and Public Safety Network.
 8. Reports on feature usage, system activity, etc. shall be available upon request either on site or remotely.
 9. Direct Dialing, two-way amplified voice intercom between any provided telephone and speaker without the use of a press-to-talk or talk-listen switch.
 10. DISA: Direct Inward System Access. The system can be configured to allow access to all system features/functions (paging, intercom, evacuation tones, class tone schedule selection, etc.) from any offsite DTMF dialing telephone via the district provided Telephone Network. Only authorized individuals may use this feature by dialing into the system through a dedicated trunk number, with or without a pass code, and then dialing a system function.
 11. Ability to place two levels of call-in from any call-in switch
 12. The ability to answer intercom call-ins registered at pre-selected telephones.
 13. The ability to automatically reroute incoming call-ins to an alternate telephone or group of telephones if they remain unanswered for a predetermined amount of time.
 14. System must support data style structured cabling utilizing Patch Panels that allow quick, Cat5e/6 (LAN cable) connection of various headend, distributed and classroom devices. Speakers shall be wired using a single Category 5e/6 cable. Wiring for all speakers shall be with one Cat5e/6 cable drop per location. Systems requiring a custom cable plant will not be acceptable.
 15. The ability to remotely locate VoIP Controller(s) (Gateways) among MDF and IDF equipment closets. This flexibility allows for the most economical wiring of the system based on

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the layout of the facility thus eliminating the need for individual home run wiring per previous standard.

16. The ability to initiate Class of Service changes either manually or automatically on a per station basis based on time of day, day of the week, and calendar via the integrated master clock.
17. A minimum of sixty-four (64) unique Classes of Service shall be available.
18. Ability to perform any system feature or function from any authorized telephone.

B. Intercom/Paging/Tones/Clock Correction Module

1. Provide an integrated intercom module for individual room intercommunications, all page and zone page, evacuation tones, prerecorded messages, multilevel call-in, secondary clock correction, and class change tones. The module shall be from the same manufacturer as the VoIP Controller (Gateway) to ensure compatibility. The module shall integrate directly with the VoIP Controller and will not require analog or digital tie lines to the VoIP Controller. Module shall provide the following integrated features and functions that integrate seamlessly with the VoIP Controller:
 - a) Two-way communication between any telephone and any room speaker.
 - b) Preannounce tone prior to connecting any intercom conversation to alert the user to the call and prevent unauthorized monitoring. A tone shall be automatically repeated at regular intervals for the duration of the intercom call if the voice circuit is not activated. A requirement to meet existing privacy laws.
 - c) Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
 - d) Single button access from any telephone on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers. Emergency announcements originating from any assigned administrative telephone shall have priority over all regular system functions.
 - e) Single button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. Up to Sixteen (16) separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.
 - f) The system will have the ability to utilize a web-browser and USB microphone to deliver live emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The system must be capable of automatically notifying district personnel via the WAN of an alarm condition.
 - g) The system can automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
 - h) Multilevel call-ins can be placed from either a classroom telephone or a call-in switch. The call-ins route to select or all administrative telephones and can only be cleared from the system once answered from an administrative telephone. If a call-in is not answered within a preprogrammed time the call-in may reroute to other administrative telephone(s) announce over selected or all speakers and shall have the capability to

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also reroute calls to predefined Mobile telephones. Emergency Call-ins may can also be programmed to send e-mail alerts to specific addresses

- i) Classroom teachers shall have the capability to exclude pages and tones from their individual classroom for testing or other purposes. This exclusion cannot affect emergency pages. This exclusion will reset at midnight.
- j) An option for Call Assurance call-in switches. When the normal or emergency button is pressed, an LED lights up to visually confirm that a call-in has been placed.
- k) The system can automatically alter a call switch's class of service by time of day and date via the integrated master clock.
- l) The capability to assign speaker locations to any one or more of the sixteen (16) independent zones for zone paging, sixteen (16) independent program/music distribution zones and sixteen (16) independent class change tone reception; this assignment is a programmable function. Each location shall be programmed in software to belong to any combination of software zones. Software/hardwired zones must be configured as part of an unlimited number of district wide groups for school district emergency announcements. These district announcements must be accessed via microphone, a web-browser or telephone.
- m) Automatic class change tones sent through all or selected intercom/paging speakers and/or horns. Any combination of up to Sixteen (16) tones can be sounded to indicate different events. Up to sixteen (16) different class change schedules can be stored in the system and selected manually from an administrative telephone, web browser or selected automatically based on time, day of the week, and date. Tone type and duration are selectable for each class change event. An unlimited number of class change events can be programmed as part of the system.
- n) Programmable "Music-on-Class-Change." A program source can be automatically routed to select zones of paging speakers or all speakers within the facility during each class change period.
- o) The system shall provide facilities to distribute program material (i.e. cassette tape, CD, radio broadcasts) in the following manner:
 - 1) The user shall cue remotely located music source or select radio station.
 - 2) From an Administrative Telephone the user can select the room(s) or areas to distribute program.
 - 3) Automated distribution based on event schedule.
- p) The module provides for secondary clock correction with the following features and functions:
 - 1) User programmable Automatic Daylight Savings Time Change.
 - 2) Latched operation of zone outputs to control lighting or other devices.
 - 3) Interface with most types of secondary slave clocks whether synchronous wired, wireless or electronic.
 - 4) User-programmable custom slave clock correction. Output relays rated at 5 amperes shall be provided on all zone circuits as necessary.
 - 5) Ability to correct and power secondary clocks using same Cat 6 supporting intercom speakers, classroom telephone, call switch and motion detector. Secondary clocks requiring more than 15 mA shall not be acceptable.

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- q) System has the ability to sync system time to the Atomic Clock Signal or to the school's or districts network time server. System has the ability to offset system time (+) or (-) 15 minutes from true atomic time to accommodate bus schedules or other scheduling issues.
- r) The module provides for classroom security and call switch supervision with the following features and functions:
 - 1) System shall be capable (future) to accept multiple alarm inputs from the main security and/or fire alarm system. Emergency tones and/or announcements can therefore be triggered, via the primary security and/or fire alarm system, to provide redundant annunciation using the classroom and corridor speakers.
- s) Intercom and paging speakers/horns can be assignable to any one or more of the sixteen (16) zones for zone paging, up to sixteen (16) zones for program distribution, and sixteen (16) zones for class change tones. Any of these zones may be part of a district created emergency paging zones allowing paging groups of different facilities within the school district. All of these zones may be configured to be independent of the other zones and in any combination. Below is an example of a paging zone scheme. The initial scheme at HS shall be determined by the Owner.
 - 1) Grade PreK-1
 - 2) Grade 2-4
 - 3) Grade 5-6
 - 4) Grade 7-8
 - 5) Grade 9
 - 6) Grade 10
 - 7) Grade 11
 - 8) Grade 12
 - 9) Teachers' lounge and workrooms.
 - 10) Common Areas
 - 11) Administrative Areas
 - 12) North Outside Speaker Area
 - 13) South Outside Speaker Area
 - 14) West Outside Speaker Area
 - 15) East Outside Speaker Area
 - 16) Gymnasium

C. Audio Paging/Program Amplifiers

- 1. Power amplifier(s) shall provide a minimum of ½ watt of power to all intercom speakers, 2 watts of power to all paging speakers, and 15 watts of power to all paging horns.
- 2. The maximum load on the paging/program amplifiers shall be 80% of the rated maximum output of the amplifiers.
- 3. Corridor & Exterior Horn Amplifiers:
 - a) Ashley NX754, four channel, 75w per channel, rack mounted amplifiers

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- b) Ashley NX752, two channel, 75w per channel, rack mounted amplifiers
- c) Refer to drawings for location of each type of Amp.

D. Surface Speaker / Electronic Display Housing & Baffle

- 1. Surface mounted housing: Rauland ACC3011SBB
- 2. Speaker / Display Baffle: Rauland ACC3011S with Rauland US0880 8 inch speaker and 2 patch cables. Rauland IP Classroom Module TCC2011A shall be provided separately.

E. IP ceiling mounted speaker assemblies

- 1. Ceiling speaker assemblies shall consist of an 8 in. round coaxial speaker with integral RJ-45 Network Jack (Rauland ACC1480) and IP Classroom Module (Rauland TCC2011A) an insulated metal backbox, and a metal ceiling tile support bridge. The ceiling speaker shall incorporate the following components, functions, and features:
- 2. Frequency range shall be 65Hz to 17kHz.
- 3. Power rating shall be 8 watts RMS.
- 4. Sensitivity shall be 93 dB @ 4 ft. with 1-watt input.
- 5. Magnet shall be 5.0 oz. ceramic.
- 6. Voice coil impedance shall be 8 ohms.
- 7. Transformer taps for 25/70 v. shall be 5/16, 5/8, 1 ¼, 2 ½, and 5 watts.
- 8. Metal insulated backbox shall be a model ACC1101 by Rauland-Borg Corp.
- 9. Ceiling tile support bridge shall be a model ACC1104 by Rauland-Borg Corp.

F. Analog ceiling mounted speaker assemblies

- 1. Ceiling speaker assemblies shall consist of an 8 in. round coaxial speaker with integral 25-volt transformer, an insulated metal backbox, and a metal ceiling tile support bridge. The ceiling speaker shall incorporate the following components, functions, and features:
- 2. Speaker shall be 8 in. round coaxial design pre-assembled with integral 25/70-volt transformer and white circular grille.
- 3. Frequency range shall be 65Hz to 17kHz.
- 4. Power rating shall be 8 watts RMS.
- 5. Sensitivity shall be 93 dB @ 4 ft. with 1-watt input.
- 6. Magnet shall be 5.0 oz. ceramic.
- 7. Voice coil impedance shall be 8 ohms.
- 8. Transformer taps for 25/70 v. shall be 5/16, 5/8, 1 ¼, 2 ½, and 5 watts.
- 9. Speaker assembly shall be a model ACC1401 by Rauland-Borg Corp.
- 10. Metal insulated backbox shall be a model ACC1101 by Rauland-Borg Corp.

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11. Ceiling tile support bridge shall be a model ACC1104 by Rauland-Borg Corp.

G. Analog wall mounted speaker assemblies

1. Wall mounted speaker assemblies shall consist of an 8 in. diameter speaker housed in a prefabricated metal housing with a metal grille. The speaker shall be provided from the factory with a 25/70V transformer and the entire assembly shall come from the manufacturer pre-assembled.
2. Speaker Type: 8 inch (20.3 cm) Permanent Magnet, with "Whizzer" cone for extended high-frequency response.
3. Power Rating: 8 watts RMS
4. Sensitivity: 93 dB @ 1 meter with 1 Watt input
5. Frequency Response: 65 to 17,000 Hertz
6. Magnet: 5 oz. (141.7 g) ceramic
7. Voice Coil Impedance: 8 ohms
8. Voice Coil Diameter: 0.75 inches (1.9 cm)
9. Transformer: 25V/70V
10. Taps at 5/16, 5/8, 11/4, 21/2, and 5 Watts
11. Baffle Size: Square 11 1/2" (29.2 cm)
12. Housing and Baffle Finish: Textured Off-White Epoxy Semi-Gloss
13. Dimensions: 11 5/8 in. wide, 5 1/2 in. deep at top, 3 1/8 in. deep at bottom, 11 3/8 in. high
14. Weight: 4 lbs., 2 oz.
15. Wall mount Speaker Assemblies shall be a model ACC1208 by Rauland-Borg.

H. Paging Horn Speaker Assemblies

1. Paging horns shall be a wide-angle paging projector consisting of an integrated driver assembly combined with a double re-entrant, non-resonant heavy-duty ABS resin horn.
2. Paging horns shall contain a built-in, weatherproofed 25- and 70-volt line matching transformer and shall be provided with a screwdriver adjustable impedance wattage switch.
3. Power taps shall be available as follows: 1.8, 3.7, 7.5, and 15 watts on 25-volt lines.
4. The loudspeaker driver assembly shall have a heavy-duty magnet, and a self-aligning, field replaceable diaphragm.
5. Power handling capacity shall be 30 watts at full range and produce 107dB at 1 meter on axis with 1-watt input.
6. Frequency response shall be 225 to 14,000 Hz.
7. Dispersion shall be no less than 120° horizontal and no greater than 60° vertical.
8. The assembly shall include a die-cast universal mounting bracket permitting single locking pin adjustment on vertical or horizontal planes.

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9. Termination to the device shall be by means of screw terminals, protected by an environmental cover, and having an integral cable strain relief.
10. The unit shall be totally weatherproof, with horn and reflex cone construction of heavy-duty high-impact ABS resin.
11. The driver and transformer housing and mounting bracket shall be weatherproof heavy die-cast aluminum. All exposed parts and hardware shall be entirely impervious to weather.
12. Finish shall be gray.
13. Dimensions shall not exceed 14-1/4" wide, 6" high, 13-11/16" deep.
14. Paging horn speaker assemblies shall be a model 3603 by Rauland-Borg.
15. Provide Rauland Model A30G weather tight adaptor for exterior horns.

I. ADMINISTRATIVE TELEPHONE

1. The administrative telephones shall have the capability of placing calls to classroom speakers or speaker zones, originating a facility-wide all-call announcement, answering incoming calls originating from classroom call buttons, and performing system programming functions such as speaker zone assignment.
2. One of the administrative phones shall be outfitted with a digital readout device for display of incoming call origination points and programming information.
3. The Administrative Telephone shall be a model TCC2045 by Rauland-Borg.
 - a. Cottage Lane Elementary School: provide a quantity of one (1). Coordinate location with owner.
 - b. Wm Schaefer Elementary School: provide a quantity of one (1). Coordinate location with owner.

J. EMERGENCY ALL-CALL MICROPHONE

1. Provide a desktop microphone with lockable "push-to-talk" bar at location to be determined by Owner. One shall be provided for the HS. One shall be provided for Pakanasink ES.
2. The desktop microphone shall be a dual-impedance type with an omnidirectional pattern.
3. Frequency Response: 50Hz – 12kHz
4. Dynamic moving coil incorporating Mylar diaphragm.
5. Height to be no greater than 9 3/8 in. with microphone head angled for ease of use.
6. Case construction: Durable molded Cylolac in black with zinc die-cast matching base.
7. Push-to-talk bar with locking mechanism.
8. Slide switch for impedance selection located on underside of base.
9. Integral 7 ft. heavy-duty 4-conductor cable included.
10. The Emergency All-Call Microphone shall be a model 1295 by Rauland-Borg.

- a. Provide a quantity of one (1) per School.
- 11. Provide (1) Rauland Microphone Input Module # TCC2077 for each Microphone.
- K. IP Classroom Module: Model TCC2011A
- L. Zone Paging Module: Model TCC2022 by Rauland Borg and associated Rauland TCC2099 rack mounting brackets to mount three ZPM's in each bracket.
- M. Aux I/O Module: Model TCC2033 by Rauland Borg
- N. Program Module: Rauland TCC2055
- O. Campus Controller: Model TCC2000 by Rauland Borg
- P. Campus Edition Enterprise Software: TCU3000SW Controller Software and TCC3100SW Stream to SIP Software by Rauland Borg
- Q. System Server: Provide Server and Operating Software for Campus Edition Enterprise Software.
- R. Program Line Input Module: Model TCC2055 by Rauland Borg
- S. Media Player with Bluetooth Receiver and AM/FM Tuner: Model DN-3000Z by Denon.
- T. Floor Rack: SOCS Middle School: As required to house all equipment in Main Sound System Rack. BGR Series by Middle Atlantic, refer to Specifications Section 271100.
- U. Override Relays: Provide override relays at local sound systems for Auditoriums, Gymnasiums and Cafeterias.
- V. Electronic Displays:
 - 1. Rauland TCC3100S Message Board.
 - 2. Mounting Accessories for installation in Rauland ACC3011S Baffle and associated Rauland ACC3011SBB Backbox.
 - 3. Mounting Accessories and back box for surface wall mounting.
- W. Large Electronic Displays:
 - 1. Rauland TCC3012L Large Message Board.
 - 2. Mounting Accessories and back box for surface wall mounting.
 - 3. Provide a custom wire guard with 9 gauge wire material as manufactured by STI.
<https://www.sti-usa.com/custom-wire-cages/>

2.03 LOCKDOWN ACTIVATION BUTTONS

- A. Wall Mounted: Design Make STI
 - 1. STI # SS2272LD-EN
- B. Under Desk Mounts:
 - 1. Honeywell #269R

2.04 BLUE LOCKDOWN STROBES

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- A. Amber Lenses have been tested to meet UL 1971 light distribution
- B. Choice of strobe lens colors – amber, blue, red (some models or by special order)
- C. Field selectable candela settings of 15/30/75/95cd or high intensity models with 115/177cd settings
- D. Indoor 24VDC models with UL “Regulated Voltage” at 16-33 VDC using filtered DC or unfiltered FWR input voltage
- E. Multitone appliance
- F. Strobes can be synchronized with Wheelock’s DSM sync modules or SAFEPATH™4 power supplies
- G. Combination speaker/strobes available for voice messages with visual alerting
- H. Mount to standard electrical boxes
- I. High quality designs from the leader in fire notification alarms
- J. Exterior shall be weather proof and include surface mount box
- K. Design Make: Interior: Wheelock -RSSB-24MCC-NW, Exterior Wheelock -MTWPB-2475W-NW
- L. Provide wire guards in gymnasiums.

2.05 NAC BOOSTER

- A. Provide a NAC Booster to power, supervise and synchronize the Blue lockdown strobes
- B. Inputs
 - 1. 120VAC, 50/60Hz
 - 2. 24VDC Battery Backup Connection
 - 3. Two (2), 12V or 24V NAC Initiating Circuits (8-33V at 5mA) • FWR or DC
 - 4. Two (2) “Dry” Contact initiating Circuits • Accepts two (2) Class “A” or two (2) Class “B” circuit inputs
 - 5. Built in battery charger for sealed lead acid or gel type batteries •
- C. Outputs
 - 1. NAC outputs are 24VDC, 3.0 Amps each, power limited
 - 2. 8 Amps on PS-8 -LP total alarm current
 - 3. Capable of four (4), Class “B” circuits
 - 4. Capable of two (2) Class “A” circuits Capable of one (1) Class “A” circuit and two (2) Class “B” circuits
 - 5. Capable of (8) Class “B” or four (4) Class “A” circuits with optional PS-EXP module
 - 6. Wheelock Sync output or True input to output follower mode
 - 7. Built-in Wheelock synchronization mode that can be fed to any or all of the output circuits
 - 8. Input and output can be synchronized with “IN>OUT SYNC” mode (DSM, 2nd POWERPATH
- D. Black Enclosure

- E. Provide batteries for 24 hours of supervision followed by 10 minutes of operation.
- F. Provide 4 circuit expansion module as needed
- G. Design Make: Wheelock - PS-8-B-LP (NAC), Wheelock – PS-EXP (expander)

2.06 RELAY INTERFACE UNIT – SYSTEM INTEGRATION

- A. Blue Strobes
 - 1. Provide a dry contact output for activation of the NAC Booster(s).
- B. Access Control
 - 1. Provide a dry contact output for activation of an access control input.
 - 2. Program the system to disable all card for all card readers – except for pre-programmed law enforcement cards.
- C. Fire Alarm
 - 1. Provide a dry contact output for activation of the Fire alarm door holder circuits.
 - 2. Configure/Program the input to release all fire doors on lockdown activation. District's Fire Alarm System Maintenance Vendor is OSI Metro, Sean Werlau, 914-241-0057.
- D. Fire Alarm Panel Cellular Dialer / Digital Communicator: The Existing FA Cellular Dialer shall continue to be re-used to communicate a lockdown. Install new 18/2 alarm cable between Rauland Sound & Lockdown System to send alarm to FA Panel Cell Dialer. District's Fire Alarm System Maintenance Vendor is OSI Metro, Sean Werlau, 914-241-0057.

2.07 UNINTERRUPTABLE POWER SUPPLIES (UPS):

- 1. Cottage Lane Elementary School:
 - a) Provide a UPS and associated batteries for the Main Sound System Rack to provide two hours of power back up.
 - b) Provide APC SRT2200RMXLA UPS with SRT72BP Battery Pack and as 9641 Management Card.
- 2. Wm Schaefer Elementary School:
 - a) Provide a UPS and associated batteries for the Main Sound System Rack to provide two hours of power back up.
 - b) Provide APC SRT2200RMXLA UPS with SRT72BP Battery Pack and as 9641 Management Card.

2.08 CAT 6 PATCH CABLES

- 1. Provide all patch cables as required at the network rack and the end devices to interconnect equipment with Cat 6 horizontal wiring and end equipment devices.
- 2. Provide Cat 6 Patch Cables, 28 Gauge, Legrand 576-RD40-00X (purple).
- 3. Provide quantity and lengths as required by the project. Refer to the Drawings. Field investigate project requirement prior to ordering.

PART 3 PART 3 – EXECUTION**3.01 GENERAL**

- A. **EXAMINATION:** Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network. Do not proceed until unsatisfactory conditions have been corrected.
- B. Demolition of existing sound systems.
 - 1. The Cottage Lane Elementary School has one Main Sound Rack and associated speaker, horns and wiring that are to be removed. All speaker cabling associated with this sound rack shall be removed in its entirety. Existing local sound systems for Cafeteria and Gymnasiums will remain and outfitted with override relays to allow for All Call and Emergency Paging to override local programming.
 - 2. The Wm Schaefer Elementary School has one Main Sound Rack and associated speaker, horns and wiring that are to be removed. All speaker cabling associated with this sound rack shall be removed in its entirety. Existing local sound systems for Cafeteria and Gymnasiums will remain and outfitted with override relays to allow for All Call and Emergency Paging to override local programming.

3.02 INSTALLATION

- 1. **General:** Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.
- 2. Furnish and install all material, devices, components and equipment for a complete operational system.
- 3. **Impedance and Level Matching:** Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.
- 4. **Control Circuit Wiring:** Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
- 5. All housings are to be located as indicated.
- 6. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.
- 7. **Wiring within Enclosures:** Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
- 8. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.
- 9. **Identification of Conductors and Cables:** Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

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10. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.03 INTEGRATION WITH OTHER SYSTEMS FOR AUTOMATED LOCKDOWN

1. Rauland TCU System and software shall be integrated as follows:
 - a) Fire Alarm System:
 - 1) Integrate to the Fire Alarm System to release magnetic hold opens when the Panic Button (Lockdown) is initiated.
 - 2) Integrate with the existing fire alarm system cellular dialer so that if a lockdown is initiated by the Rauland Telecenter System then the lockdown signal is sent to the Fire Alarm Panel's cellular dialer to report a lockdown at the school.
 - b) 911 Notification – Coordinate with Owner if it is desired to dial 911 when the Panic Button (Lockdown) is initiated.
 - c) Door Access Control: Integrate with the existing Avigilon Door Access Control System to restrict access to doors with Card Reader when the Panic Button (Lockdown) is initiated. Provide DAC system programming as required by the District's DAC vendor, Day Automation (Service Center: 800-836-0969).
 - d) Text Alerts – Coordinate with the Owner if it is desirable to broadcast text alerts when the Panic Button (Lockdown) is initiated.
 - e) Telephone System: Coordinate with the Owner to program the NEC VOIP telephone system to allow a four-digit code to be programmed to launch a lockdown thru the new Rauland TCU system. The NEC VOIP Telephone system programming will be performed by the District's Telephone system vendor, Newcastle Communications and not included in the Electrical Contract.
2. Furnish and install all material, devices, components, and equipment for a complete operational system.

3.04 GROUNDING

1. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
2. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.
3. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

3.05 FIELD QUALITY CONTROL

1. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
2. Inspection: Make observations to verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

3. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.06 FINAL ACCEPTANCE TESTING

1. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.
2. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.
3. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.07 COMMISSIONING

- A. The contractor shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 1.6, paragraphs 3, 5 & 6 of these specifications. In addition to the Training Materials provided, the contractor will also furnish Operators Manuals and Users Guides at the time of this training.
- B. Schedule training with Owner through the owner's representative, with at least seven days advance notice.

3.08 OCCUPANCY ADJUSTMENTS

- A. The contractor shall provide Occupancy Adjustments in accordance with Section 1.6, paragraph 9 of these specifications. A response scenario amenable to both the owner and the contractor will be established and followed for the first year of service.

3.09 CLEANING AND PROTECTION

- A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

END OF SECTION

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SECTION 28 13 33**ACCESS CONTROL DEVICES****PART 1 GENERAL****1.01 SUMMARY**

- A. This document includes a general description, functional requirements, operational characteristics, and criteria for Card Access Equipment(CAE).
- B. New Door Access Control System improvements shall be commissioned so that all devices are programmed properly and system is in working order.
- C. South Orangetown CSD has an existing Avigilon Door Access Control System installed at all facilities. This system will be expanded as shown on the drawings. Day Automation provides maintenance on the Avigilon DAC system and is an Avigilon vendor. Please see the below contact information:

Stacy Pucillo
Regional Business Development Manager
Day Automation
973-703-4440
Stacy.pucillo@dayautomation.com

1.02 REFERENCES

- A. The Codes and Regulations listed below form a part of this specification to the extent referenced. Work shall be performed in accordance with the applicable international, federal, state, and local codes or standards current at the commencement of installation. The following list summarizes applicable standards:
 - 1. UL 294, UL 1076, ULC
 - 2. CE
 - 3. FCC – Part 15, Part 68
 - 4. NFPA 70, NEC
 - 5. IEEE, RS 170 variable standard
 - 6. Microsoft® Open Database Connectivity (ODBC) interface)
 - 7. ISO Software Coding Standards for C++ and C##
 - 8. RoHS
- B. Where more than one code or regulation is applicable, the more stringent shall apply.

1.03 SMS DESCRIPTION

- A. The Security Management System (SMS) shall be based on Avigilon ACC Enterprise Video Surveillance and Avigilon ACM Door Access Control Software. This section lists the equipment needed to obtain the card access functionality of the SMS system.

1.04 QUALITY ASSURANCE**A. Manufacturer Qualifications**

1. Manufacturer of the Card Access Equipment CAE shall be an established organization with referenced and documented experience delivering and maintaining Security Management Systems of equal or higher sophistication and complexity as compared to the system detailed in this specification.
2. CAE Manufacturer's manufacturing facilities shall be certified ISO-9000:2000 operations, utilize ISO-9000:2000 manufacturing procedures and maintain their ISO certifications.
3. CAE Manufacturer shall employ at a minimum the following methods for QA of component and assembly devices.
 - a) Visual inspection of devices shall be performed to verify assembly according to defined procedures. End of line operational tests shall be performed to ensure product functionality has been correctly configured. A system burn-in period shall be utilized to screen for early life failures of electronic components.
4. Individual functionality and system level regression testing shall be performed to ensure compliance with product specifications. Single and multiple unit system tests shall be performed to mimic end-user installation configurations. Automated hardware and software testing shall be utilized to evaluate system performance under published operational loads and shall be compared to published system capabilities.

B. Bidder Qualifications

1. At the time of the bid, the bidder shall have satisfactorily completed projects similar size, scope and complexity as the system detailed in this specification. The bidder shall furnish written proof of experience from three (3) references and proof of current accreditation/certification by the manufacturer for required training for sales/installation/service of the SMS and associated devices.
2. The bidder shall also be a factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for the SMS and related systems under this contract. Local shall be defined as an area in a (**X) mile radius of installed location.)

PART 2 PRODUCTS**2.01 PHYSICAL ACCESS CONTROL SYSTEM (PACS) APPLIANCE**

- A. MFR: Avigilon
- B. Provide Avigilon Access Control Manager License as required.

2.02 INTELLIGENT SINGLE DOOR CONTROLLER (AC-MER-CONT_1DR)

- A. The AC-MER-CONT-1DR is a powerful, intelligent controller solution for managing one or two onboard readers (expandable to seventeen (17) readers) with Avigilon's Access Control Manager.
- B. PoE capable intelligent network controller

- C. Single-door interface that can expand to 17 reader doors
- D. Suitable for in/out reader applications
- E. Network ready
- F. Decentralizes system intelligence
- G. Triple gang footprint
- H. Provides full local processing Interfaces with a wide array of reader technologies including Wiegand, clock and data, magnetic stripe and keypads
- I. Support for up to eight (8) device addresses through the on board RS-485 communication port
- J. Support for the AC-MER-CON-MR50, AC-MER-CON-MR52, AC-MER-CONMR16IN and the AC-MER-CON-MR16OUT
- K. Support for the AC-MER-CON-MR51E over Ethernet
- L. Provide Avigilon Access Control Manager License as required.

2.03 INPUT CONTROL MODULE (AC-MER-CON-MR16IN)

- A. The Input Control Module shall provide 16 UL 1076 Grade B, A or AA alarm input zones and monitor / report line fault conditions, alarm conditions, power faults and tampers. Status LEDs shall provide information about the sixteen alarm zone inputs, cabinet tamper, and power fault.
- B. In addition, the ICM shall incorporate the following features:
 - 1. UL 294, ULC, and CE Certified
 - 2. Alarm contact status scanning at up to 180 times per second for each zone
 - 3. Eight configuration DIP switches to assign unit addresses and communications speed
 - 4. Elevator control support for 128 floors
 - 5. Variable resistor values for line supervision
 - 6. A low power CMOS microprocessor
 - 7. Filtered data for noise rejection to prevent false alarms
 - 8. Up to 16 Grade B, A, or AA Supervised Inputs in any Combination
 - 9. 12 or 24 VDC Input Power
 - 10. 2 Form C 5A, 30 VDC Contacts for load switching
 - 11. 2 dedicated inputs for tamper and power status
 - 12. RoHS Compliance
 - 13. Support for RS-485 over CAT 5, 6e cable
- C. Provide Avigilon Access Control Manager License as required.

2.04 SINGLE READER INTERFACE MODULE (AC-MER-CON-MR50)

- A. The SRI shall provide an interface between the ISC and authentication devices. The SRI must operate with any authentication device that produces a standard Wiegand, Data 1 / Data 0) or Clock and Data communication output.

- B. In addition the SRI shall incorporate the following features:
1. 12 or 24 VDC power supply
 2. Reader communications (Clock/Data or Wiegand Data1/Data0) - more than 150 different readers approved for use
 3. Two Form-C relay outputs (5 A Door Strike and 1 A Aux relays)
 4. Up to 16 different card formats (8 card and 8 asset)
 5. Issue code support for Magnetic and Wiegand formats
 6. Door contact Open or Closed, Supervised or Non-supervised
 7. REX push-button monitor - Supervised or Non-supervised
 8. Strike Control output
 9. Dedicated tamper and power failure circuits
 10. Bicolor or two wire status LED support
 11. Beeper control
 12. Support for offline reader access mode
 13. Elevator control, support for 64 floors
 14. UL 294 listed and CE approved
 15. RoHS Compliance
 16. Support for RS-485 over CAT 5, 6e cable
- C. Provide Avigilon Access Control Manager License as required.

2.05 MULTI CLASS CARD READER

- A. iCLASS SE: R10/RP10
- B. Non-default programmable options include: additionally support
1. Standard iCLASS Access Control Application (order with Standard interpreter)
 2. ISO14443A (MIFARE) CSN, ISO14443B CSN, ISO15693 CSN
 3. ISO14443A/B (FIPS-201 Transparent FASC-N Read) (order -F model with FIPS interpreter)
- C. Compatible with cards, reader interface module and SMS software
- D. Green/red – valid/void leds
- E. Tamper resistant mounting
- F. Legacy, Weigand, Black
- G. Model No. 900PTNNEK00000

2.06 VIDEO INTERCOM STATIONS (VIC)

- A. Video Intercom Stations and related equipment shall be provided by the Electrical Contractor and install be by a technician certified by the VIC Manufacturer.
- B. Acceptable Manufacturers: Avigilon

- C. Avigilon Part No. 3.0C-H4VI-RO1-IR with Surface enclosure (Part # H4VI-SURF1) and Safety Relay (Part # H4VI-RELY1)
- D. New VIC will be powered by POE Network Connection.
- E. Contractor to review existing conditions prior to ordering and installing VIC.
- F. Electrical Contractor to interface door release contacts in VIC with Door Access Control System.
- G. VIC software shall also be installed on computer, provided by Owner, at Greeters Desk and be fully integrate to communicate with VIC on exterior of building and control operation of electric door strike on exterior vestibule door.
- H. Provide Avigilon Video Surveillance license for the VIC and integrate the VIC to the District's Avigilon VMS system for recording all video.

2.07 ELECTRIC DOOR STRIKES (EDS)

- A. Electric Door Strikes to be provided by others (General Contractor).

2.08 RECESSED DOOR CONTACTS

- A. The contact contains a hermetically sealed magnetic reed switch. The reed shall be potted in the contact housing with a polyurethane based compound. Contact and magnet housing shall snap-lock into a 3/4" or 1" dia. hole. Housings shall be molded of flame retardant ABS plastic. Color of housings shall be off-white, gray or mahogany brown. The magnet shall be made of Alnico V. Rare Earth Magnet shall be made of neodymium iron boron.
- B. Design Make: Sentrol (Interlogix) 1076 / 1078 Series

2.09 SURFACE DOOR CONTACTS

- A. The contact shall be a hermetically sealed reed switch nominally 3" L x 1" H x 0.50" D with matching actuating magnet. Mounting holes shall be on 2" centers. Contact and magnets shall be in brushed anodized aluminum tube housing. Contact shall be sealed in our exclusive polyurethane potting compound. Right angle mounting bracket shall be furnished with contact, #1912. Contacts shall be specified as part numbers 2505A, 2507A, 2507AD, 2507AH.
- B. The contact shall be a Form C (SPDT) reed contact biased with an Alnico VII magnet. Contact will be difficult to defeat with an external magnet. Three feet of flex stainless steel conduit shall be permanently attached to the contacts.
- C. Design Make: Sentrol 2500 Series.

2.10 REQUEST TO EXIT MOTION DETECTOR (REX)

- A. For use in request-to-exit (REX) applications.
- B. Provides PIR 2.4 m x 3 m (8 ft x 10 ft) coverage, timers, door monitor with sounder alert, and pointable coverage. Door monitor with sounder alert
- C. Sequential Logic Input (SLI)
- D. Internal vertical pointability
- E. Wrap-around coverage pattern with precise pattern control
- F. Up to 64 second adjustable latch time
- G. Design Make: BOSCH DS 160 with Bosch TP160 Trim Plate.

2.11 DOOR RELEASE BUTTON (DRB)

- A. For use to release Electric Door Strikes on security entrance doors.
- B. Install in single gang electrical box

- C. MFR: SONEW. Part No. SONEWYKQFZB96PG
- D. Current Rating 3Amps
- E. Voltage Rating 36VDC
- F. Stainless Steel Faceplate with engraved black lettering and with illuminated button.

PART 3 EXECUTION

3.01 SECURITY MANAGEMENT SYSTEM

- A. Installation:
 - 1. Install all equipment and materials in accordance with the recommendations of the manufacturer.
 - 2. Provide all wiring as required by the manufacturer. Provide plenum rated cable as required.
- B. Programming of the system shall include the following tasks:
 - 1. Coordinate all system programming and configuration with the facility's security maintenance staff.
 - 2. Programming system configuration parameters (hardware and software, reader/circuit numbers, communication parameters).
 - 3. Programming operational parameters such as the card holder database, time zones, access levels and reader definitions.
 - 4. Programming passcodes according to the authorities and functions defined by the Owner.
 - 5. Other system programming tasks required by the Owner. These additional programming requirements shall be coordinated between the Owner, security maintenance staff and the contractor.
- C. Testing:
 - 1. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components re fully operational.
 - 2. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all

3.02 CARD READER

- A. Install card readers in locations shown on plans. Install readers past the swing of the door.
- B. Provide surface mount back boxes only where needed. Where possible provide flush mount back boxes that can be covered by the card reader. When needed the door jam or a hallow wall can be used as the junction point for the card reader connections.

3.03 ELECTRIC DOOR STRIKES AND ELECTRC LATCH RETRATION

- A. Electric Door Strikes will be provided by the General Contractor and wired by the Electrical Contactor.

3.04 COMMISSIONING

- A. 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.

3.05 WARRANTY

- A. The Contractor shall provide a single written document outlining the warranty of the manufacturer(s) product and the contractor's installation, on a single document. The document shall warrant complete installation of all services and equipment to be free from defects in materials and workmanship for a period of no less than one (1) year, starting with the date of Final System Acceptance.
- B. Contractor shall provide any software maintenance patches and version updates or upgrades at no-additional cost to Owner for a period of at least one (1) year.

END OF SECTION

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SECTION 28 16 00
INTRUSION DETECTION SYSTEM

PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes an Intrusion Detection System consisting of electric door monitoring hardware, motion sensing devices, system controllers, monitor/control stations or keypads, and associated equipment.
- B. The Existing Intrusion Detection Systems in Cottage Lane ES and William Schaefer ES are a ADT Focus 200 Intrusion Detection System. Parts for the System and associated motion detectors are no longer made. Therefore, the existing Motion Detectors need to be re-used. Contractor shall be carefull when removing motion detectors as they will be reused.
- C. The District's Intrusion Detection Maintenance Contractor is:
- Open System Metro
258 Route 117 By Pass Road
Bedford Hills, NY 10507
www.osmetro.com
Sean Werlau
Account Executive
914-241-0057
swerlau@osmetro.com
- D. The existing intrusion detection systems at Cottage Lane Elementary School and William Schaefer Elementary School will be modified to accommodate the renovations to the schools. This includes but is not limited to motion detectors and associated wiring. Existing alarm points, such as door contacts, shall be maintained.
- E. Some of the existing motion detectors will be relocated and the associated wiring will be extended to similar locations in the same space. It is important to re-install the same motion detector in the same space because of how the Intrusion Detection System is programmed. All wiring will need to be extended as required for the new locations of the relocated motion detectors. Refer to the Drawings for more detail.
- F. Contractor shall survey all facilities and document existing system prior to demolition and provide complete inventory of intrusion detection devices.
- G. Related Sections:

1. SECTION 27 05 11 – Requirements for Communications Systems
2. SECTION 27 05 28 – Interior Pathways
3. SECTION 28 13 33 – Access Control Devices

1.3 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. PIR: Passive infrared.
- C. RFI: Radio-frequency interference.
- D. UPS: Uninterruptible power supply.
- E. Control Unit: System component that monitors inputs and controls outputs through various circuits.
- F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
- G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
- H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
- I. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
- J. Zone. A defined area within a protected premise. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
 1. Include manufacturer's technical data for all material and equipment at the system and sub system level to be provided as part of the system.
 2. Provide complete manufacturer's data for each item listed in PART 2 below.
- B. Shop Drawings:

1. Intrusion Detection Cable to be used for extensions.

C. Contract Close-Out Submittals:

1. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the Access Control System to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the Access Control System. Copies of the final as-built drawings shall be provided to the end user hard copy and electronic format.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. System Vendor shall be certified by existing intrusion detection system Manufacturer and shall be an established organization with referenced and documented experience delivering and maintaining Security Management Systems of equal or higher sophistication and complexity as compared to the system detailed in this specification.

B. Bidder Qualifications: The Bidder shall be regularly engaged in the installation and maintenance of specified systems and shall meet the following qualifications at the time of the bid:

1. Shall have satisfactorily completed projects of similar size, scope, and complexity as the system detailed in this specification. The bidder shall furnish written proof of experience on the submitted System from three (3) references and proof of current accreditation/certification by the manufacturer for the required training necessary for local sales, installation, and service of the System and associated devices. The Bidder shall not be considered qualified to bid this project unless they can provide a list of projects, similar in size and scope to this project, with the submitted system completed by the local organization within the last five years. Local shall be defined as an area in a 50 mile radius of this contract's project location.
2. Shall be a factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for the System and related systems under this contract.
3. Hold a valid Security system installers license by the State of New York.
4. To the fullest extent possible, provide products of the same kind, from a single source, and from the same manufacturer.

C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

D. The Contractor and the System Vendor are jointly responsible to remedy defects due to faulty workmanship and materials that appear within one year from the date of acceptance in accordance with the General Conditions, unless Specifications specify a different duration

E. The system modifications shall include all wiring, installation, supervision, calibration, adjustments, and checkout necessary for a complete and fully operational system.

- F. The System contractor shall have single source responsibility of the complete installation and proper operation of the system as specified and shall include debugging and proper calibration and commissioning of each component in the modified system.

1.6 WARRANTY

- A. Special Warranty: System modifications shall only be associated with the warranty.
 - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONTROL PANEL (existing)

- A. The District has ADT Focus 200 Intrusion Detection Panels. These panels will be utilized to support all intrusion detection system modifications.

2.2 MOTION PIR DETECTORS

- A. Reuse Existing Motion Detectors as shown on the Drawings.

2.3 INTRUSION DETECTION CABLING

- A. OmniCable, Part No. G111602
- B. 16 Gauge, Stranded, 2 Conductor, shielded, Plenum (CMP), white.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with UL 681 and NFPA 731.
- B. Connecting to Existing Equipment: Verify that the existing Intrusion detection system is operational before making changes or connections.
 - 1. Connect equipment to existing control panel in existing part of the building.

3.2 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceways according to SECTION 27 05 28 – Interior Pathways, except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces

and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals.
- B. Install instructions frame in a location visible from master control unit.

3.4 TESTING

- A. Existing system testing:
 - 1. Contractor shall test existing system components that are being modified in presence of Owner's Representative and issue a report to the Owner and Architect listing conditions found prior to any removals, relocations, or additions.
- B. Pre-testing: After installation, align, adjust, and balance system and perform complete pre-testing to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
 - 1. Report of Pre-testing: After pre-testing is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
- C. Acceptance testing: Acceptance test and performance demonstration shall be developed and documented by the System Vendor. These requirements shall apply to all system components that have been modified or added to the system. The System Vendor shall perform the tests and document the results under the supervision and witnessing of the Owner's Representative.
 - 1. Submit written test report from authorized representative of equipment manufacturer stating that system has been tested and is in working order prior to final inspection by Engineer.
 - 2. Provide complete panel real-time printout as documentation of device, date and time.
 - 3. Provide inspection complying with requirements of applicable NFPA standards.
 - 4. Intrusion Detection: As applicable, identify device by number and by owner's room names/numbers assigned to each device.

5. In addition to NFPA 731 requirements the following shall be checked for proper operation, tested as applicable and all results documented/submitted.
 - a. Software programming.
6. Submit written test report from an authorized representative of the equipment manufacturer that system has been tested and approved.
7. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
 - a. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
 - b. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
8. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.5 SYSTEM PROGRAMMING

- A. The Contractor and the System Vendor are jointly responsible for Re - Programming and report formatting of the System as specified herein and as directed by the owner/owner representative. The owner will convey their programmable operational requirements for all system functions in lay terms, and Initial System programming will be completed to satisfy the owner's requirements.
- B. The Contractor and the Vendor will be required to meet with the owner's representatives to discuss, recommend and document the owner's needs for programming and sequences of operation.

END OF SECTION

SECTION 28 35 50
SECURITY & TECHNOLOGY EQUIPMENT

PART 1 GENERAL**1.01 SYSTEM DESCRIPTION**

- A. Electrical Contractor shall coordinate with the Owner when removing and re-installing Wireless Access Points (WAPs) and Mounting Brackets in locations shown on the drawings. This shall include recording of WAP MAC Addresses and device location, installation of patch cables at the wireless access point locations.
- B. Electrical Contractor shall coordinate with the Owner for the modifications of the existing and new telecommunication racks to minimize network disruptions. Any network shutdown shall be coordinated with the Owner.
- C. Electrical Contractor shall coordinate with the Owner when removing and re-installing IP cameras and mounting brackets in locations shown on the drawings. This shall include recording of IP Camera MAC Addresses and device location, installation of patch cables at the camera locations. Coordinate with Owner for final re-aiming of cameras.
- D. The Owner is responsible for removing and re-installing Flat Panels and associated mounting brackets in locations shown on the drawings. EC shall coordinate with Owner and the GC when installing Power and communications cabling and associated raceways to the new flat panel locations.
- E. Telecommunications equipment shall be grounded and bonded in accordance with ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications and Article 800, 2002 National Electric Code.
- E. Electrical Contractor shall coordinate with the General Contractor to provide electrical power (120VAC) and/or IP network Cabling for all door access control panels, power supplies and electric door strikes. Refer to drawings for locations and quantities.
- G. All materials furnished and all work performed shall comply with all State, County and Local Codes.
- H. All equipment and work shall comply with FCC regulations.

PART 2 PRODUCTS**2.01 HDMI JACK INSERTS AT FLAT PANELS**

- A. Legrand On-Q 4K HDMI Coupler Keystone Insert, Black
- B. Part No. WP124KBK.
- C. 4K @ 60Hz, 18Gbps Rated

2.02 HDMI CABLE FOR FLAT PANELS

- A. Mono Price Product # 12735 High Speed HDMI Cable
- B. Lengths from 25Ft to 100Ft. Field verify all lengths prior to ordering.
- C. 4K @ 60Hz, 18Gbps Rated
- D. CL2 fire safety rating
- E. Confirm cable type with Owner prior to ordering cable.

2.03 USB EXTENSION CABLING (CAT 6)

- A. New Flat Panel installations will have a USB Extension between the Teacher's Stations and the flat panel. This will be accomplished by installing a Cat 6 cable and associated Cat 6 Data Jacks. The Owner will then purchase a Cat 6 to USB Converter to be used at the Teacher's Station and the flat panel.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Equipment, mounting brackets and patch cables must be installed in accordance with the manufacturer's specifications and industry best practices. Submit for Owner review and approval an installation work plan and schedule. Coordinate with the owner.
- B. Removal and disposal of all packaging and unused installation materials.

3.02 PRESENCE AT CUTOVER

- A. At all times during installation of new systems, maintain existing (prior to cutover) services. Any necessary disruptions to service must be clearly communicated in advance and approved by the Owner.

END OF SECTION

**SECTION 284601
FIRE ALARM SYSTEM (EXISTING SYSTEM)****PART 1 - GENERAL****1.1 SCOPE & RELATED DOCUMENTS**

- A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations in connection with the modifications and additions to the existing Fire Alarm System(s) as shown on the drawings and as herein specified.
- B. The requirements of the conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.
- C. The complete installation is to conform to the applicable sections of NFPA-72, NFPA-71, Local Code Requirements and National Electrical Code with particular attention to Article 760.
- D. Additionally, the entire installed system and all integrated system operations shall be within the guidelines of the SBCCI Standard Building Code.
- E. The work covered by this section of the specifications is to be coordinated with the related work as specified elsewhere under the project specifications.
- F. The contractor shall provide all required modifications and additions to the existing Fire Alarm System for the removal, relocation of existing devices and addition of new devices. This shall include all additional wiring, devices, modifications to the existing control panel, additional components and modules, addressable cards, testing, troubleshooting and instructions to the owner.

1.2 QUALITY ASSURANCE

- A. Each and all items of the Fire Alarm System shall be listed compatible with the existing system under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. All control equipment is to be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.
- B. All items shall match and be of the same manufacturer as the existing system.
- C. The equipment and installation supervision furnished under this specification is to be provided by a manufacturer who has been engaged in production of this type (software driven) of equipment for at least ten (10) years, and has a fully-equipped service organization within thirty-five (35) miles of the installation.
- D. All control equipment must have transient protection devices to comply with UL864 requirements.
- E. In addition to the UL-UOJZ requirement mentioned above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760-23.
- F. Supplier shall provide documentation that fire alarm technicians are NICET LEVEL 2 certified (minimum of four).
- G. Suppliers' service organization must have been established in the local area for a minimum of ten (10) years with ten (10) years experience on specific equipment brand supplied.

1.3 SUBMITTALS

- A. Submit shop drawings for each piece of equipment specified including complete wiring and connection diagrams.
- B. All submittals shall be submitted in a single complete brochure, which shall be in the form of a soft cover binder with each group separated by an identified index tab.
- C. Submittals that fail to comply with the above requirements will automatically be rejected.
- D. It is the Contractor's responsibility to provide submittals in an organized and timely manner in order so as not to delay the project schedule and hamper the work of other trades.

E. Submit certificate of Fire Alarm System operating tests.

PART 2 PRODUCTS

2.1 PERIPHERAL DEVICES

- A. The Contractor shall furnish and install addressable devices that are compatible with the existing Cerberus Pyrotronics fire alarm System
- B. Devices Required but not limited to:
 - 1. Manual Pull Stations
 - 2. Smoke Detectors
 - 3. Duct Smoke Detectors
 - 4. Combination Speaker/Strobe Stations
 - 5. Visual Alarm (Strobe) Stations
 - 6. Auxiliary contacts on devices where indicated on drawings.
 - 7. Magnetic fire door holds
 - 8. Power Supplies
 - 9. Addressable Relay modules

2.2 MAGNETIC DOOR HOLDERS

- A. Description: Units shall be listed to UL 228. Units shall be equipped for wall or floor mounting as indicated on plans and are complete with matching door plate and extension arms as required. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source from fire alarm panel. Magnets must develop a minimum of 25 lbs. holding force for any of these voltages.
- B. Material and Finish: Match door hardware. All final hardware material and finishes must be coordinate with the GC.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide and install all devices in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC - Article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760 A and B. Upon completion, the contractor shall so certify in writing to the owner and general contractor.
 - 1. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.
- B. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- C. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.
- D. The manufacturer's authorized representative shall provide on-site supervision of installation.

3.2 TESTING

- A. The completed fire alarm system shall be fully tested in accordance with NFPA-72H by the contractor in the presence of the owner's representative and the Local Fire Marshal. Upon completion of a successful test, the contractor shall so certify in writing to the owner and general contractor.

3.3 WARRANTY

- A. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of first beneficial use.

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**FIRE ALARM SYSTEM
(EXISTING SYSTEM)**

284601

- B. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72H guidelines.

END OF SECTION

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SECTION 311000
SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

1.2 SUBMITTALS

- A. Site Plan: Showing:
 - 1. Areas for temporary construction and field offices.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.1 SITE CLEARING

- A. Comply with other requirements specified in Section 017000.
- B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.2 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their 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 not to be removed.

3.3 VEGETATION

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
- B. Do not remove or damage vegetation beyond the limits indicated on drawings.
- C. Install substantial, highly visible fences exactly 4 feet to prevent inadvertent damage to vegetation to remain:
 - 1. At vegetation removal limits.
 - 2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
- D. In areas where vegetation must be removed but no construction will occur other than previous paving, remove vegetation with minimum disturbance of the subsoil.
- E. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
 - 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 - 2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches (450 mm).
 - 3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
 - 4. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.
- F. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

- G. 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.

3.4 DEBRIS

- A. Remove debris, junk, and trash from site.
B. Leave site in clean condition, ready for subsequent work.
C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 312200
GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Removal of topsoil.
- B. Rough grading the site for site structures.
- C. Finish grading.

1.2 RELATED REQUIREMENTS

- A. Section 311000 - Site Clearing.

1.3 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 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.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.
- D. 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.
- E. 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.
- F. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.3 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.

3.4 SOIL REMOVAL

- A. Stockpile topsoil to be re-used on site; remove remainder from site.
- B. Stockpiles: Coordinate location with owner; pile depth not to exceed 10'; protect from erosion.

3.5 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 (13 mm) in size. Remove soil contaminated with petroleum products.
- C. Where topsoil is to be placed, scarify surface to depth of 3 inches (75 mm).
- D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 6 inches (150 mm).
- E. Place topsoil in areas where seeding, sodding, and planting are indicated.
- F. Unless otherwise indicated on the drawings place topsoil to the following compacted thicknesses:
 - 1. Areas to be Seeded with Grass: 6 inches (150 mm).
 - 2. Areas to be Sodded: 4 inches (100 mm).
 - 3. Shrub Beds: 18 inches (450 mm).
 - 4. Flower Beds: 12 inches (300 mm).
 - 5. Planter Boxes: To within 3 inches (75 mm) of box rim.
- G. Place topsoil during dry weather.
- H. Remove roots, weeds, rocks, and foreign material while spreading.
- I. Near plants spread topsoil manually to prevent damage.
- J. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- K. Lightly compact placed topsoil.
- L. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.6 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) (30 mm) from required elevation.
- B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch) (13 mm).

3.7 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.

3.8 FIELD QUALITY CONTROL

- A. See Section 312323 for compaction density testing.

3.9 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

SECTION 312316.13
TRENCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Backfilling and compacting for utilities outside the building to utility main connections.

1.2 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.

1.3 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, coordinate location with owner.
 - 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

2.1 FILL MATERIALS

- A. 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 (75 mm), rocks larger than 2 inches (50 mm), and debris.
 - 2. Complying with ASTM D2487 Group Symbol GW, GP, GM, SW, SP, and SM .
- B. Structural Fill - Fill Type Select Granular Item 203.07: Complying with State of NYS DOT standard.
- C. Concrete for Fill: Lean concrete.
- D. Granular Fill - Fill Type Bedding Stone: Pit run washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 1 inch (25 mm) sieve: 100 percent passing.
 - b. 3/8 inch (9 mm) sieve: 55 to 85 percent passing.
 - c. No. 4 (4.75 mm) sieve: 35 to 60 percent passing.
 - d. No. 40 (450 micro m): 10 to 25 percent passing.
 - e. No. 200 (75 micro m): 5 to 10 percent passing.
- E. Granular Fill - Fill Type Drainage Course : Comply with the NYS DOT Specification.
 - 1. Material shall meet the requirements of Item 605.0901, Type 1, or a 50-50 mixture of Type I and Type II (605.1001) as defined in the New York State Department of Transportation "Standard Specification".

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.2 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.

3.3 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 (1.2 meters) 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 (305 mm) into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Architect.

3.4 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.

3.5 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 (150 mm) compacted depth.
- F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm) compacted depth.
- G. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), 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 paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 2. At other locations: 95 percent of maximum dry density.
- J. Reshape and re-compact fills subjected to vehicular traffic.

3.6 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping
1. Bedding: Use Fill Type Granular Bedding Stone.
 2. Fill up to subgrade elevation.
 3. Compact in maximum 8 inch (200 mm) lifts to 95 percent of maximum dry density.
- B. At Pipe Culverts:
1. Bedding: Use Fill Type Granular Bedding Stone.
 2. Cover with general fill.
 3. Fill up to subgrade elevation.
 4. Compact in maximum 8 inch (200 mm) 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.

3.7 FIELD QUALITY CONTROL

- A. See Section 014000 - 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.

3.8 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

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SECTION 312316.26
ROCK REMOVAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Removal of discovered rock during excavation.

1.2 DEFINITIONS

- A. Rock: Solid mineral material of a size that cannot be removed with a 3/4 cubic yard (0.57 cubic meter) capacity power shovel.

1.3 REFERENCE STANDARDS

- A. NFPA 495 - Explosive Materials Code 2023.

PART 3 EXECUTION

2.1 EXAMINATION

- A. Verify site conditions and note subsurface irregularities affecting work of this section.

2.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.

2.3 ROCK REMOVAL

- A. Excavate and remove rock by either mechanical or explosive methods.
- B. Mechanical Methods: Drill holes and utilize expansive tools to fracture rock.
- C. If rock is uncovered requiring the explosives method for rock disintegration, notify the Architect.
- D. Use of Explosives: Obtain permits from authorities having jurisdiction before explosives are brought to site or drilling is started.
 - 1. Comply with NFPA 495 and applicable state and local codes.
 - 2. Prior to blasting, obtain a seismographic survey to determine maximum charges that can be used at each location in area of excavation without damaging adjacent properties or other work.
 - 3. Prior to executing seismographic survey, advise owners of adjacent buildings and structures in writing; explain planned survey and blasting operations.
 - 4. Prior to blasting, document conditions of buildings near locations of intended blasting and photograph existing conditions identifying existing irregularities.
 - 5. Schedule work to avoid working hours of occupied buildings nearby.
- E. Form level bearing at bottom of excavations.
- F. Remove shaled layers to provide sound and unshattered base for footings.
- G. In utility trenches, excavate to 6 inches (150 mm) below invert elevation of pipe and 24 inches (600 mm) wider than pipe diameter.
- H. Remove excavated materials from site.

2.4 FIELD QUALITY CONTROL

- A. Independent agency field inspection will be provided under provisions of Section 014000 - Quality Requirements.

END OF SECTION

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SECTION 312316
EXCAVATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Excavating for footings, slabs-on-grade, paving, and site structures.
- B. Trenching for utilities outside the building to utility main connections.
- C. Temporary excavation support and protection systems.

1.2 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction Current Edition.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Field Quality Control Submittals: Document visual inspection of load-bearing excavated surfaces.

1.4 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. 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

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench mark and intended elevations for the work are as indicated.
- B. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot (305 mm) 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 (305 mm) into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by Geotechnical Engineer.

3.2 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.

3.3 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

- A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.

3.4 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.
- B. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Provide temporary means and methods, as required, to remove all water from excavations. See Section 312319. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.5 SUBGRADE PREPARATION

- A. See Section 312323 for subgrade preparation at general excavations.
- B. See Section 312316.13 for subgrade preparation at utility trenches.

3.6 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. See Section 312323 for fill, backfill, and compaction requirements at general excavations.
- C. See Section 312316.13 for fill, backfill, and compaction requirements at utility trenches.
- D. See Section 312200 for rough and final grading and topsoil replacement requirements.

3.7 FIELD QUALITY CONTROL

- A. See Section 014000 - 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.

3.8 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.

3.9 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

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**SECTION 312319
DEWATERING**

ACTION SUBMITTALS

1.1 SHOP DRAWINGS:

- A. For dewatering system, prepared by or under the supervision of a qualified professional engineer.
- B. Include plans, elevations, sections, and details.
- C. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
- D. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
- E. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

FIELD CONDITIONS

2.1 PROJECT SITE INFORMATION

- A. Make test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
- B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

2.2 PRODUCTS

A. PERFORMANCE REQUIREMENTS

- 1. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
- 2. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
- 3. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
- 4. Prevent surface water from entering excavations by grading, dikes, or other means.
- 5. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
- 6. Remove dewatering system when no longer required for construction.
- 7. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

2.3 EXECUTION

A. PREPARATION

- 1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
- 2. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.

- 3. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
- C. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- D. Provide temporary grading to facilitate dewatering and control of surface water.
- E. Protect and maintain temporary erosion and sedimentation controls, during dewatering operations.

2.4 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- B. Space well points or wells at intervals required to provide sufficient dewatering.
- C. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- D. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- E. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

2.5 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
- C. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- F. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

2.6 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
- D. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- E. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- F. Prepare reports of observations.

2.7 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION

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SECTION 312323
FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Filling, backfilling, and compacting for slabs-on-grade, paving, and sidewalks.
- B. Backfilling and compacting for utilities outside the building to utility main connections.
- C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.
- D. Lightweight concrete fill.

1.2 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.

1.4 WARRANTY

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

PART 2 PRODUCTS

2.1 FILL MATERIALS

- A. 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 (75 mm), rocks larger than 2 inches (50 mm), and debris.
 - 2. Complying with ASTM D2487 Group Symbol GW, GP, GM, SW, SP, and SM .
- B. Structural Fill - Fill Type Select Granular: Complying with State of New York Department of Transportation (Item 203.07 and Section 733-11) standard.
- C. Concrete for Fill: Lean concrete.
- D. Granular Fill - Fill Type Bedding Stone: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 1 inch (25 mm) sieve: 100 percent passing.
 - b. 3/8 inch (9 mm) sieve: 55 to 85 percent passing.
 - c. No. 4 (4.75 mm) sieve: 35 to 60 percent passing.
 - d. No. 40 (450 micro m): 10 to 25 percent passing.
 - e. No. 200 (75 micro m): 5 to 10 percent passing.
- E. Granular Fill - Fill Type Drainage Course: NYS DOT Specification.
 - 1. Material shall meet the requirements of Item 605.0901, Type 1, or a 50-50 mixture of Type I and Type II (605.1001) as defined in the New York State Department of Transportation "Standard Specification".
- F. Sand: 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.
- G. Topsoil: See Section 312200.
- H. Engineered Fill - Lightweight Concrete:
 - 1. Materials:
 - a. Cement: ASTM C150/C150M.

- b. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.
- c. Admixtures: As recommended by lightweight concrete fill manufacturer.
- d. Expansion Material: Manufacturer's recommended expansion material.
- e. Mix Design: By manufacturer.

2.2 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

2.3 SOURCE QUALITY CONTROL

- A. See Section 014000 - 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

3.1 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Verify areas to be filled are not compromised with surface or ground water.

3.2 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 6 inches (150 mm) 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.

3.3 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 (150 mm) compacted depth.
- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm) compacted depth.
- H. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), 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: 95 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.

3.4 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 (50 mm) of elevation indicated on drawings.

3.5 FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated.
- B. Structural Fill at locations indicated on the drawings.:
 1. Use structural fill.
 2. Maximum depth per lift: 8 inches (200 mm), compacted.
 3. Compact to minimum 95 percent of maximum dry density.
- C. Over Buried Utility Piping in Trenches and as indicated on the drawings :
 1. Bedding: If not Indicated on the drawings, use granular fill (Bedding Stone).
 2. Cover with general fill.
 3. Fill up to subgrade elevation.
 4. Compact in maximum 8 inch (200 mm) lifts to 95 percent of maximum dry density.
- D. At Lawn Areas:
 1. Use general fill.
 2. Compact to 95 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 95 percent of maximum dry density.
 3. See Section 312200 for topsoil placement.
- F. At French Drains:
 1. Use Drainage Fill .

3.6 TOLERANCES

- A. Top Surface of General Filling: Plus or minus 1 inch (25 mm) from required elevations.
- B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch (25 mm) from required elevations.

3.7 FIELD QUALITY CONTROL

- A. See Section 014000 - 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.

END OF SECTION

SECTION 312500
EROSION AND SEDIMENTATION CONTROL**PART 1 GENERAL****1.1 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.

1.2 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.

1.3 QUALITY ASSURANCE

- A. 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.
- B. 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.
- C. 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.
- D. The limits of cleared areas shall be physically delineated to protect areas designated as undisturbed.
- E. 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.
- F. Continue erosion control measures until the permanent measures have been sufficiently established and are capable of controlling erosion on their own.
- G. The control of dust, erosion and sediment originating from construction operations is considered a critical responsibility of the Contractor. The Owner's Representative will be the final judge of the adequacy of the Contractor's dust, erosion and sedimentation control. The Owner's Representative may suspend work until adequate dust, erosion and sedimentation control is attained. The Contractor shall bear the costs of repair work and restoration of damaged items.

PART 1 PRODUCTS**2.1 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.

2.2 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 cover 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.

2.3 SEED AND SOD FOR EROSION CONTROL

- A. For temporary seeding in spring, summer or early fall, seed the area with ryegrass, (annual or perennial) or approved equal at 30 lbs per acre. For temporary seeding in late fall or early winter, seed the area with Certified winter rye (cereal rye) or approved equal at 100 lbs per acre. Mulch area with hay or straw at 2 tons per acre. Mulch anchoring may be required where wind or areas of concentrated water are a concern.
- B. For permanent seeding on slopes, provide a seed according to the following or as shown on the Contract Drawings
 - 1. Erosion control areas are to be seeded at a rate of: 50 pounds per acre with a mix consisting of 70% Ernst Best Strip Mine Mix (ERNMX-101) and 30% Ernst Shaded Roadside Mix (ERNMX-140), as supplied by Ernst Conservation Seeds, or as approved by Owner.

2.4 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.

2.5 STABILIZED CONSTRUCTION ENTRANCE

- A. Material shall be clean, sound, crushed stone of uniform quality.
- B. Geotextile filter cloth (Mirafi 500X, or equal) designed for heavy-duty haul road use.

2.6 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 1 EXECUTION

3.1 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.

3.2 MATTING/BLANKETS - GENERAL

- A. Prepare surfaces of ditches and slopes to conform to the grades, contours and cross sections as shown on the Drawings and finish to a smooth and even condition with all debris, roots, stone, and lumps raked out and removed. Loosen the soil surface to permit bedding of the matting. Unless otherwise noted, seed prior to the placement of the matting.
- B. Unroll matting parallel to the direction of flow of water and loosely drape, without folds or stretching, so that continuous ground contact is maintained.
- C. The ditches and swales, and on slopes, each upslope and each downslope end of each piece of matting shall be placed in a 6" trench, stapled at 12" on center, backfilled, and tamped. Similarly, bury edges of matting along the edges of catch basins and other structures. Owner's Representative may require that any other edge, exposed to more than normal flow of water, be buried in a similar fashion.
- D. Tightly secure matting to the soil by staples driven approximately vertically into the ground, flush with the surface of the matting. In driving the staples, take care not to form depressions or bulges in the surface of the matting.
- E. Decrease the specified spacing of staples when varying factors, such as the season of the year or the amount of water encountered or anticipated, requires additional anchoring.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 MAINTENANCE

- A. If any staples become loosened or raised, or if any matting becomes loose, torn, or undermined, or if any temporary erosion and sediment control measures are disturbed, repair them immediately.
- B. If the seed is washed out before germination, repair any damage, refertilize, and reseed.
- C. Maintain mulched and matted areas, silt stops, and other temporary control measures until the permanent control measures are established and no further erosion is likely.
- D. All sediment spilled, dropped, or washed onto the driveway or public right-of-way shall be removed immediately.
- E. Maintain ditches and swales at all times so that they effectively drain. Refill, reshape, and recompact where ruts or erosion occurs.
- F. Maintain areas temporarily seeded including repair of all damages, re-seeding, and refertilizing.
- G. Take special precautions in the use of construction equipment to minimize erosion. Do not leave wheel tracks where erosion might begin. Prevent direct discharge from dewatering pumps and surface runoff from the construction sites to storm sewers, culverts, streams or ditches. Intercept and conduct surface runoff and discharge from dewatering pumps to siltation ponds before discharging to natural drainage channels.

END OF SECTION

SECTION 321123
AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aggregate base course.
- B. Paving aggregates.

1.2 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 2022, with Errata .
- B. 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).
- C. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)) 2012 (Reapproved 2021).
- E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.
- F. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2023.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When aggregate materials need to be stored on site, locate where directed by Owner.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Coarse Aggregate as indicated on the drawings or Type 304.12: Coarse aggregate, complying with State of NY DOT standard.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.2 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.3 INSTALLATION

- A. Place aggregate in maximum 4 inch (100 mm) layers and roller compact to specified density.

- B. Level and contour surfaces to elevations and gradients indicated.
- C. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- D. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- E. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch (6.4 mm) measured with 10 foot (3 m) straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch (6.4 mm).
- C. Variation From Design Elevation: Within 1/2 inch (12.8 mm).

3.5 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor"), or ASTM D1557 ("modified Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.6 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

SECTION 321216
ASPHALT PAVING

PART 1 GENERAL

1.1 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.

1.2 REFERENCE STANDARDS

- A. AI MS-2 - Asphalt Mix Design Methods 2015.
- B. AI MS-19 - Basic Asphalt Emulsion Manual 2008.
- C. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction 2009a.

1.3 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.

1.4 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.

PART 2 PRODUCTS

2.1 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.

2.2 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 9.5 F2 HMA 80 Series.
 - 2. Binder Course: NYSDOT 19 F9 HMA 80 Series
 - 3. Base Course: NYSDOT 37.5 F9 HMA 80 Series.
 - 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

3.1 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.2 BASE COURSE

- A. Place and compact base course.

3.3 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 (1.5 L/sq m).
- C. Use clean sand to blot excess primer.

3.4 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd (1.5 L/sq m).

3.5 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.

3.6 SEAL COAT

- A. Apply seal coat to surface course and asphalt curbs in accordance with AI MS-19.

3.7 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch (6 mm) measured with 10 foot (3 m) straight edge.
- B. Variation from True Elevation: Within 1/2 inch (12 mm).

3.8 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for quality control.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549/D 3549M.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979/D 979M.
- F. Replace and compact hot-mix asphalt where core tests were taken, if any.
- G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

**SECTION 321313
CONCRETE PAVING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete sidewalks, stair steps, and integral curbs.

1.2 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete 1991 (Reapproved 2009).
- B. ACI 301 - Specifications for Concrete Construction 2020.
- C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- D. ACI 305R - Guide to Hot Weather Concreting 2020.
- E. ACI 306R - Guide to Cold Weather Concreting 2016.
- F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2022.
- G. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2022.
- H. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.
- I. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2022.
- J. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.
- K. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing 2017.
- L. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2018.

PART 2 PRODUCTS

2.1 PAVING ASSEMBLIES

- A. Comply with applicable requirements of ACI 301.

2.2 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.

2.3 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 80 (80,000 psi) (550 MPa) 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 (280 MPa) yield strength; deformed billet steel bars; unfinished finish.

2.4 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 inch (12 mm) length.
 - 1. Manufacturers:
 - a. Propex Concrete Systems (FiberMesh 300)
 - b. Substitutions: See Section 016000 - Product Requirements.

2.5 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1, Class A.
- B. Slab Isolation Joint Filler: 1/2 inch (13 mm) thick, height equal to slab thickness, with removable top section that will form 1/2 inch (13 mm) deep sealant pocket after removal.
 - 1. Material: ASTM D1751, cellulose fiber.

2.6 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 (0.89 kg per cubic meter), 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; 4,500 psi.

2.7 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

3.1 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.2 SUBBASE

- A. See Section 321123 for construction of base course for work of this Section.

3.3 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.

3.4 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.

3.5 REINFORCEMENT

- A. Place reinforcement as indicated.

- B. Interrupt reinforcement at contraction joints.
- C. Place dowels to achieve pavement and curb alignment as detailed.

3.6 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 (4 degrees C), or surface is wet or frozen.

3.7 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.

3.8 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Saw cut contraction joints 3/16 inch (5 mm) wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.9 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 (6 mm 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 (6 mm) in 10 ft (3 m).
- B. Maximum Variation From True Position: 1/4 inch (6 mm).

3.11 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - 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 (76 cu m) 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

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SECTION 321723.13
PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, and curb markings.
- B. Roadway lane markings and crosswalk markings.

1.2 REFERENCE STANDARDS

- A. FS TT-B-1325 - Beads (Glass Spheres) Retro-Reflective 2007d (Validated 2017).
- B. FS TT-P-1952 - Paint, Traffic and Airfield Marking, Waterborne 2015f (Validated 2020).
- C. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.
- D. FHWA MUTCD - Manual on Uniform Traffic Control Devices 2010, with Errata.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons (18 L) accompanied by batch certificate.
- B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment accompanied by batch certificate.
- C. Store products in manufacturer's unopened packaging until ready for installation.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.4 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; white and yellow.
 - 1. Roadway Markings: As required by authorities having jurisdiction.
 - 2. Parking Lots: as indicated on drawings or yellow.
 - 3. Handicapped Symbols: as indicated on drawing or Blue.
- B. Paint For Obliterating Existing Markings: FS TT-P-1952; black for bituminous pavements, gray for portland cement pavements.
- C. Reflective Glass Beads: FS TT-B-1325, Type I (low index of refraction), Gradation A (coarse, drop-on) ; with silicone or other suitable waterproofing coating to ensure free flow.
- D. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.
- E. All paint shall conform to current Federal, State and Local air pollution regulations, including those for the control (emission) of volatile organic compounds (VOC) as established by the U.S. EPA, and the NYSDEC

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Clean surfaces thoroughly prior to installation.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
- D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
- E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.
- F. Temporary Pavement Markings: When required or directed by Architect, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.
 - 1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.
 - 2. At Contractor's option, temporary marking tape may be used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

3.3 INSTALLATION

- A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F (10 degrees C) or more than 95 degrees F (35 degrees C).
- C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- D. Comply with FHWA MUTCD manual (<http://mutcd.fhwa.dot.gov>) for details not shown.
- E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
- F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.
 - 1. Apply paint in one coat only.
 - 2. Wet Film Thickness: 0.015 inch (0.4 mm), minimum.
 - 3. Length Tolerance: Plus or minus 2 inches.
 - 4. Width Tolerance: Plus or minus 1/8 inch (3 mm).
- G. Roadway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.
 - 1. Conduct operations in such a manner that necessary traffic can move without hindrance.
 - 2. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
 - 3. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.

4. Skip Markings: Synchronize one or more paint "guns" to automatically begin and cut off paint flow; make length of intervals as indicated.
 5. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.
 6. Distribute glass beads uniformly on the paint lines within ten seconds without any waste, applied at rate of 6 pounds per gallon (720 g per L) of paint; if the marking equipment does not have a glass bead dispenser, use a separate piece of equipment adjusted and synchronized with the paint applicator; remove and replace markings having faulty distribution of beads.
- H. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
1. Mark the International Handicapped Symbol at indicated parking spaces.
 2. Hand application by pneumatic spray is acceptable.
- I. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.4 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
- C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
- D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
- E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.
- F. Replace removed markings at no additional cost to Owner.

END OF SECTION

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SECTION 329219
SEEDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Placing topsoil.
- B. Hydroseeding, mulching and fertilizer.
- C. Maintenance.

1.2 RELATED REQUIREMENTS

- A. Section 312200 - Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.

1.3 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.

1.4 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

2.1 SEED MIXTURE

- A. Seed Mixture:
 - 1. Kentucky Blue Grass: 33 percent.
 - 2. Creeping Red Fescue Grass: 33 percent.
 - 3. Norlea Perennial Rye: 34 percent.

2.2 SOIL MATERIALS

- A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

2.3 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.
- 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.

2.4 TESTS

- A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- B. Submit minimum 10 oz (280 g) sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.
- C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that prepared soil base is ready to receive the work of this Section.

3.2 PREPARATION

- A. Place topsoil in accordance with Section 312200.

3.3 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- D. Mix thoroughly into upper 2 inches (50 mm) of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.4 SEEDING

- A. Apply seed at a rate of 2 lbs per 1000 sq ft (____) evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- D. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.
- E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.
- F. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.5 HYDROSEEDING

- A. Apply seeded slurry with a hydraulic seeder at a rate of 1500-lb/acre dry weight evenly in two intersecting directions.
- B. Do not hydroseed area in excess of that which can be mulched on same day.
- C. Immediately following seeding, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.

- D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.
- E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.6 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
- B. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.
- C. Provide maintenance of seeded areas for three months from Date of Substantial Completion.
- D. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
- E. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches (65 mm). Do not cut more than 1/3 of grass blade at any one mowing.
- F. Neatly trim edges and hand clip where necessary.
- G. Immediately remove clippings after mowing and trimming.
- H. Water to prevent grass and soil from drying out.
- I. Roll surface to remove minor depressions or irregularities.
- J. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- K. Immediately reseed areas that show bare spots.
- L. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

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SECTION 329223
SODDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fertilizing.
- B. Sod installation.
- C. Maintenance.

1.2 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.

1.3 REFERENCE STANDARDS

- A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding 2006.

1.4 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.

1.5 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.

1.6 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

2.1 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.

2.2 MATERIALS

- A. Sod: TPI (SPEC), Certified Turfgrass Sod quality; cultivated grass sod; type indicated in plant schedule on Drawings; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft (100 sq m). 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 (25 mm) and maximum 1-3/8 inch (35 mm) 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.

2.3 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 (50 mm) size.
- C. Edging: Galvanized steel.

2.4 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

3.1 EXAMINATION

- A. Verify that prepared soil base is ready to receive the work of this section.

3.2 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 (50 mm) of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.3 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 (300 mm) 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 (13 mm) below top of hard surface.
- F. On slopes 6 inches per foot (500 mm per m) and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet (600 mm) on center. Drive pegs flush with soil portion of sod.
- G. Prior to placing sod, on slopes exceeding 8 inches per foot (666 mm per m) 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 (100 mm) 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.

3.4 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 (65 mm). 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

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SECTION 329300
PLANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Topsoil bedding.
- C. New trees, plants, and ground cover.
- D. Mulch and Fertilizer.
- E. Maintenance.
- F. Tree Pruning.

1.2 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.

1.3 REFERENCE STANDARDS

- A. ANSI/AHIA Z60.1 - American National Standard for Nursery Stock 2014.
- B. ANSI A300 Part 1 - American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices (Pruning) 2017.

1.4 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.

1.5 QUALITY ASSURANCE

- A. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.

1.6 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.

1.7 FIELD CONDITIONS

- A. Do not install plant life when ambient temperatures may drop below 35 degrees F (2 degrees C) or rise above 90 degrees F (32 degrees C).
- B. Do not install plant life when wind velocity exceeds 30 mph (48 k/hr).

1.8 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

2.1 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.

2.2 PLANTS

- A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

2.3 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.

2.4 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.

2.5 MULCH MATERIALS

- A. Mulching Material: Shredded hardwood bark, free of growth or germination inhibiting ingredients.

2.6 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.

2.7 TOP SOIL MIX

- A. A uniform mixture of 1 part peat and 3 parts topsoil by volume.

2.8 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

3.1 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.

3.2 PREPARATION OF SUBSOIL

- A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
- C. Scarify subsoil to a depth of 3 inches (75 mm) where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
- D. Dig pits and beds 6 inches (150 mm) larger than plant root system.

3.3 PLACING TOPSOIL

- A. Spread topsoil to a minimum depth of 4 inches (100 mm) over area to be planted. Rake smooth.
- B. Place topsoil during dry weather and on dry unfrozen subgrade.
- C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
- D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
- E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches (150 mm).

3.4 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after initial raking of topsoil.
- C. Mix thoroughly into upper 2 inches (50 mm) of topsoil.
- D. Lightly water to aid the dissipation of fertilizer.

3.5 PLANTING

- A. Place plants for best appearance.
- B. Set plants vertical.
- C. Remove non-biodegradable root containers.
- D. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches (of 150 mm) under each plant. Remove burlap, ropes, and wires, from the root ball.
- E. Place bare root plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch (150 mm) layers. Maintain plant life in vertical position.
- F. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.6 INSTALLATION OF ACCESSORIES

- A. Wrap deciduous shade and flowering tree trunks and place tree protectors.

3.7 PLANT SUPPORT

- A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:
 - 1. Tree Caliper: 2 to 4 inches (50 to 100 mm); Tree Support Method: 3 guy wires with eye bolts and turn buckles

3.8 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.

3.9 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner.

- B. Maintain plant life for 12 months after Date of Substantial Completion.
- C. Irrigate sufficiently to saturate root system and prevent soil from drying out.
- D. Remove dead or broken branches and treat pruned areas or other wounds.
- E. Neatly trim plants where necessary.
- F. Immediately remove clippings after trimming.
- G. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions.
- H. Control insect damage and disease. Apply pesticides in accordance with manufacturers instructions.
- I. Remedy damage from use of herbicides and pesticides.
- J. Replace mulch when deteriorated.
- K. Maintain wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

END OF SECTION

SECTION 330561
CONCRETE MANHOLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Modular precast concrete manhole sections with tongue-and-groove joints with masonry transition to lid frame, covers, anchorage, and accessories.

1.2 REFERENCE STANDARDS

- A. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2022.
- B. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections 2019.
- C. ASTM C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections (Metric) 2019.
- D. ASTM C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals (Metric) 2018.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions for each product indicated on the drawings.
- C. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of penetrations.
- D. Manufacturer's Qualification Statement.

PART 2 PRODUCTS

2.1 MANHOLES

- A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 (ASTM C478M), with resilient connectors complying with ASTM C923 (ASTM C923M).

2.2 COMPONENTS

- 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. Manhole Steps: Formed galvanized steel rungs; 3/4 inch (19 mm) diameter. Formed integral with manhole sections.

2.3 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 (300 mm) wide, 16 inches (400 mm) on center vertically, set into manhole wall.

PART 3 EXECUTION

3.1 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.

3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.3 MANHOLES

- A. Place concrete base pad, trowel top surface level.
- B. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.
- C. Form and place manhole cylinder plumb and level, to correct dimensions and elevations. As work progresses, build in fabricated metal items.
- D. Cut and fit for pipe.
- E. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.
- F. Set cover frames and covers level without tipping, to correct elevations.
- G. Coordinate with other sections of work to provide correct size, shape, and location.

3.4 MASONRY WORK

- A. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- B. Lay masonry units in running bond. Course one unit and one mortar joint to equal 8 inches (200 mm).
- C. Form concave mortar joints.
- D. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- E. Install joint reinforcement 16 inches (400 mm) on center.
- F. Place joint reinforcement in first and second horizontal joints above base pad and below lid frame opening.

END OF SECTION

SECTION 334100
SUBDRAINAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Building Perimeter, Retaining Wall, and Under-Slab Drainage Systems.
- B. Filter aggregate and fabric and bedding.

1.2 REFERENCE STANDARDS

- A. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.

1.3 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

2.1 REGULATORY REQUIREMENTS

- A. Comply with applicable code for materials and installation of the work of this section.

2.2 PIPE MATERIALS

- A. Polyvinyl Chloride Pipe: ASTM D2729; plain end, 4 inch (100 mm) inside diameter; with required fittings.
- B. Corrugated Plastic Tubing: Flexible type; 4 inch (100 mm) diameter, with required fittings.
- C. Use perforated pipe at subdrainage system; unperforated through sleeved walls.

2.3 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.

2.4 ACCESSORIES

- A. Pipe Couplings: Solid plastic.
- B. Filter Fabric: Water pervious type, black polyolefin. As indicated on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

3.2 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.

3.3 INSTALLATION

- A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.
- B. Place drainage pipe on clean cut subsoil.
- C. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- D. Loosely butt pipe ends. Place joint cover strip 12 inches (300 mm) 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 (300 mm).
- F. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.
- G. Place aggregate in maximum 4 inch (100 mm) lifts, consolidating each lift.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Field inspection and testing.

3.5 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION

SECTION 334211
STORMWATER GRAVITY PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Storm drainage piping, fittings, and accessories.
- B. Connection of drainage system to municipal sewers.
- C. Catch basins, Plant area drains, Paved area drainage, and Site surface drainage.

1.2 RELATED REQUIREMENTS

- A. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 REFERENCE STANDARDS

- A. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Drainage Pipe 2023.
- B. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter 2021.
- C. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2022.
- D. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications 2020.
- E. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.
- F. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials 2021.

1.4 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, catch basins, cleanouts, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Comply with applicable code for materials and installation of the Work of this section.

2.2 SEWER 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.
- 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 (75 mm) and 10 inches (250 mm) and AASHTO M 294, Type S, for diameters between 12 inches (300 mm) and 60 inches (1500 mm), soil-tight, bell and spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C.

2.3 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, integral cleanout, cleanout cover, and tamper proof fasteners.
 - 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, integral neoprene gaskets, and rubber coupling.

2.4 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS

- A. Lids and Drain Covers: Cast iron; heavy duty proof load.
 - 1. Catch Basin: As indicated on the drawings
- B. Standard Precast Concrete Catch Basins:
 - 1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 - 3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
 - 4. Joint Sealant: ASTM C990, bitumen or butyl rubber.
 - 5. 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.
 - 6. Pipe Connectors: ASTM C923 resilient, of size required, for each pipe connecting to base section.
 - 7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
- C. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (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.

2.5 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 312316.13.
- B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.1 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.

3.2 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 (3 mm) in 10 feet (3 m).
- C. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.

3.3 INSTALLATION - CATCH BASINS, TRENCH DRAINS AND 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.
- E. Prefabricated trench drains:
 - 1. Excavate; prepare substrate and supports according to the manufacturer's printed installation instructions.
 - 2. Install prefabricated trench drain system according to the manufacturer's printed installation instructions.
 - 3. Expansion, Construction, and Control Joints: Do not locate trench drain system on an expansion, construction or control joint in concrete or pavement. Where concrete or pavement joints running transverse to direction of flow cross the trench drain system, locate concrete or pavement joints and trench drain system joints so that both coincide.
 - 4. Concrete Trench Support: 3000 pounds per square inch (20.68 MPa) compressive strength, minimum.
 - a. Provide support on all sides of trench in minimum thickness recommended by trench drain system manufacturer.
 - b. Screed and finish top edge of concrete flush with top surface of trench drain system.
 - c. Do not use secondary edge finishing tools.

3.4 FIELD QUALITY CONTROL

- A. Perform field inspection in accordance with Section 014000 - 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: 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 in accordance with requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

- a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
- b. Option: Test plastic piping in accordance with ASTM F1417.
- 6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than **150** psig.
 - a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
 - b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.

3.5 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 334230
STORMWATER DRAINS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Precast concrete catch basins.
- B. Prefabricated drop inlets.
- C. Frames and grates.

1.2 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 2020.
- 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).

1.3 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. Shop Drawings: Indicate stack assembly, invert elevations, opening sizes, and pipe angles.
- D. Manufacturer's qualification statement.
- 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.

1.4 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

2.1 MANUFACTURERS

- A. Drainage Basins:
 - 1. Nyloplast : www.nyloplast-us.com
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.2 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 designed for A-16 (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.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 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. 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.
- D. Frames and Grates:
 1. Place frame plumb and level.
 2. Mount frame on mortar bed at indicated elevation.
 3. Place grate in frame securely.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - 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