

Gonzales Community Center Complex

PART 2B - CRITERIA DOCUMENTS

Technical Specifications

Volume 2 of 3

100% DESIGN CRITERIA DOCUMENTS

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- Plumbing
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- Low Voltage
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**SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Above ground piping.
- B. Buried piping.
- C. Escutcheons.
- D. Expansions - hose and braid.
- E. Fire rated enclosures.
- F. Mechanical couplings.
- G. Pipe hangers and supports.
- H. Pipe sleeves.
- I. Pipe sleeve-seal systems.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 09 90 00 - Painting: Preparation and painting of exterior fire protection piping systems.
- C. Section 09 91 23 - Interior Painting: Preparation and painting of interior fire protection piping systems.
- D. Section 21 05 23 - General-Duty Valves for Water-Based Fire-Suppression Piping.
- E. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment: Piping identification.
- F. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.3 REFERENCE STANDARDS

- A. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
- B. 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 2021.
- C. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- D. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use 2021.
- E. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- F. AWWA C606 - Grooved and Shouldered Joints 2015.
- G. FM (AG) - FM Approval Guide current edition.
- H. ITS (DIR) - Directory of Listed Products current edition.
- I. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems 2019.
- K. UL (DIR) - Online Certifications Directory Current Edition.

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

1.4 SUBMITTALS

- A. See Div 1 for submittal procedures.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section.
 - 1. Minimum three years experience.
- C. Comply with FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey requirements.
- D. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.
- E. 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 valves in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.7 WARRANTY

- A. See Section Div 1 for additional warranty requirements.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Sprinkler-based System:
 - 1. Comply with NFPA 13.
 - 2. See Section 21 13 00.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.
- C. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.2 BURIED PIPING

2.3 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A795 Schedule 40, black.
 - 1. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.4 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. Pipe Passing Through Below Grade Exterior Walls:
 1. Zinc-coated or cast-iron pipe.
 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- C. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Not required for wall hydrants for fire department connections or in drywall construction.
- 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. Rated Openings: Caulked tight with firestopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

2.5 PIPE SLEEVE-SEAL SYSTEMS

- A. Modular Mechanical Seals:
 1. Elastomer-based interlocking links to continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
 2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
 3. Size and select seal component materials in accordance with service requirements.
 4. Service Requirements:
 - a. Underground, buried, and wet conditions.
 5. Glass-reinforced plastic pressure end plates.
- B. Wall Sleeve: PVC material with waterstop collar, and nailer end caps.
- C. Sleeve-Forming Disk: Nonconductive plastic-based material, 3 inch (76.2 mm) thick.
- D. Pipeline-Casing Seals:
 1. End Seals: 1/8 inch (3.1 mm), pull-on type, rubber or synthetic rubber based.

2.6 FIRE-RATED ENCLOSURES

- A. Provide as required to preserve fire resistance rating of building elements.

2.7 ESCUTCHEONS

- A. Material:
 1. Chrome-plated.
 2. Metals and Finish: Comply with ASME A112.18.1.
- B. Construction:
 1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
 2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.8 PIPE HANGERS AND SUPPORTS

2.9 EXPANSION JOINTS AND LOOPS - HOSE AND BRAID

- A. Manufacturers:
 1. The Metraflex Company; FireLoop: www.metrafire.com.
 2. Substitutions: See Div. 1.

- B. Provide flexible loops with two flexible sections of hose and braid, two 90-degree elbows, and 180-degree return with support bracket and air release or drain plug.
- C. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.

2.10 MECHANICAL COUPLINGS

- A. Rigid Mechanical Couplings for Grooved Joints:
 - 1. Dimensions and Testing: Comply with AWWA C606.
 - 2. Minimum Working Pressure: 300 psig (2065 kPa).
 - 3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
 - 4. Housing Coating: Factory applied orange enamel.
 - 5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
 - 6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

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

3.2 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
- G. Pipe Hangers and Supports:
 - 1. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
 - 2. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 - 3. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.

- J. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- K. Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a watertight seal.
 - 6. Install in accordance with manufacturer's recommendations.
- L. Escutcheons:
 - 1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
 - 2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
 - 3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.
- M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

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.
- C. See Div. for additional requirements.

END OF SECTION

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SECTION 21 05 23
GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment.
- B. Section 21 13 00 - Fire-Suppression Sprinkler Systems.
- C. Section 33 14 16 - Site Water Utility Distribution Piping.

1.2 REFERENCE STANDARDS

- A. AWWA C606 - Grooved and Shouldered Joints 2015.
- B. FM (AG) - FM Approval Guide current edition.
- C. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 13R - Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies 2022.
- E. UL (DIR) - Online Certifications Directory Current Edition.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. UL Listed: Provide valves listed in UL (DIR) under following headings and bearing UL mark:
- B. FM Global Approved: Provide valves listed in FM (AG) Approval Guide under the following headings:
 - 1. Automated Sprinkler Systems:
 - a. Indicator posts.
- C. ASME Compliance:
- D. Comply with AWWA C606 for grooved-end connections.
- E. Comply with NFPA 13 and NFPA 13R for valves.
- F. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.

2.2 BRONZE BUTTERFLY VALVES WITH INDICATORS

- A. Minimum Pressure Rating: 175 psig (1200 kPa).
- B. Body Material: Bronze.
- C. Seat: EPDM.
- D. Stem: Bronze or stainless steel.
- E. Disc: Bronze with EPDM coating.
- F. Actuator: Worm gear or traveling nut.
- G. Supervisory Switch: Internal or external.

2.3 CHECK VALVES

- A. Minimum Pressure Rating: 175 psig (1200 kPa).
- B. Type: Center guided check valve.
- C. Body Material: Cast iron, ductile iron.

- D. Center guided check with elastomeric seal.
- E. Hinge Spring: Stainless steel.
- F. End Connections: Flanged, grooved, or threaded.

2.4 IRON OS&Y GATE VALVES

- A. Maximum Working Pressure: 175 psi (1,200 kPa).
- B. Body and Bonnet Material: Cast or ductile iron.
- C. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
- D. Stem: Brass, bronze, or stainless steel.
- E. Packing: Non-asbestos PTFE.
- F. Supervisory Switch: External.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Confirm valve interior to be free of foreign matter and corrosion.
- B. Remove packing materials.
- C. Examine guides and seats by operating valves from the fully open position to the fully closed position.
- D. Examine valve threads and mating pipe for form and cleanliness.

3.2 INSTALLATION

- A. Comply with specific valve installation requirements and application in the following Sections:
 - 1. Section 21 13 00 for application of valves in wet and dry pipe, fire-suppression sprinkler systems.
 - 2. Div. 33 for application of valves in fire-suppression water-service piping outside the building.
- B. Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
- C. Install check valve in water supply connections and backflow preventer at potable water supply connections.
- D. Valves in horizontal piping installed with stem at or above the pipe center.
- E. Position valves to allow full stem movement.
- F. Install valve tags. Comply with Section 21 05 53 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

END OF SECTION

SECTION 21 05 53
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.
- D. Ceiling tacks.

1.2 REFERENCE STANDARDS

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

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Automatic Controls: Tags.
- B. Control Panels: Nameplates.
- C. Instrumentation: Tags.
- D. Major Control Components: Nameplates.
- E. Piping: Tags.
- F. Pumps: Nameplates.
- G. Relays: Tags.
- H. Small-sized Equipment: Tags.
- I. Valves: Nameplates and ceiling tacks where above lay-in ceilings.

2.2 NAMEPLATES

- A. 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. Thickness: 1/8 inch (3 mm).
 - 5. Plastic: Comply with ASTM D709.

2.3 TAGS

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

2.4 PIPE MARKERS

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

- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil, 0.004 inch (0.10 mm) thick, manufactured for direct burial service.

2.5 CEILING TACKS

- A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
- F. Use tags on piping 3/4 inch (20 mm) diameter and smaller.
 - 1. Identify service, flow direction, and pressure.

END OF SECTION

SECTION 21 13 00
FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 21 05 00 - Common Work Results for Fire Suppression: Pipe and fittings.
- B. Section 21 05 23 - General-Duty Valves for Water-Based Fire-Suppression Piping.
- C. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment.

1.3 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide current edition.
- B. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements 2015.
- C. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL (DIR) - Online Certifications Directory Current Edition.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Sprinklers, Valves, and Equipment:
 - 1. Anvil International: www.anvilintl.com.
 - 2. Tyco Fire Protection Products: www.tyco-fire.com.
 - 3. Viking Corporation: www.vikinggroupinc.com.
 - 4. Substitutions: See Div. 1.

2.2 SPRINKLER SYSTEM

- A. Sprinkler System: Provide coverage for entire building.
- B. Occupancy: Light hazard; comply with NFPA 13.
- C. Water Supply: Determine volume and pressure from water flow test data.
- D. Interface system with building control system.
- E. Provide fire department connections where indicated.
- F. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.
- G. Pipe Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 3. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - 4. Other Types: As required.

2.3 SPRINKLERS

- A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
 - 1. Response Type: Quick.
 - 2. Coverage Type: Standard.
 - 3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- B. Exposed Area Type: Pendant or upright type with guard.
 - 1. Response Type: Quick.
 - 2. Coverage Type: Standard.
 - 3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
 - 1. Response Type: Quick.
 - 2. Coverage Type: Standard.
 - 3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- D. Flexible Drop System: Stainless steel, multiple use, open gate type.
 - 1. Application: Use to properly locate sprinkler heads.
 - 2. Include all supports and bracing.
 - 3. Provide braided type tube as required for the application.
 - 4. Manufacturers:

2.4 PIPING SPECIALTIES

- A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
 - 1. Activate electric alarm.
 - 2. Test and drain valve.
 - 3. Replaceable internal components without removing valve from installed position.
- B. Backflow Preventer: Reduced pressure principle valve assembly backflow preventer with drain and OS & Y gate valve on each end.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with referenced NFPA design and installation standard.

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

3.2 INTERFACE WITH OTHER PRODUCTS

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

END OF SECTION

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SECTION 22 05 16
FLEXIBLE FITTINGS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flexible pipe connectors.

1.2 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping.

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

- A. See Div. 1, for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Comply with UL (DIR) requirements.

2.2 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

2.3 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturers:
 - 1. Mercer Rubber Company: www.mercer-rubber.com.
 - 2. The Metraflex Company: www.metraflex.com.
 - 3. Substitutions: See Section 01 66 00 - Product Delivery, Storage and Handling.
- B. Inner Hose: Bronze or Stainless Steel.
- C. Exterior Sleeve: Braided bronze or Stainless Steel.
- D. Pressure Rating: 125 psi and 450 degrees F (862 kPa and 232 degrees C).
- E. Joint: As specified for pipe joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.
- H. Application: Copper piping.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

- D. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION

SECTION 22 05 17
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2016.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

1.4 SUBMITTALS

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 WARRANTY

- A. See Division 1, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PIPE SLEEVES

- A. Manufacturers:
 - 1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com.
 - 2. Jay R. Mfg. Co..
 - 3. Zurn Plumbing Products Group..
- B. 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.
- C. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- D. Pipe Passing Through Below Grade Exterior Walls:
1. Zinc coated or cast iron pipe.
 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- E. 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.
- F. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
1. Galvanized steel pipe or black iron pipe with asphalt coating.
 2. Connect sleeve with floor plate except in mechanical rooms.
- G. Penetrations in concrete beam flanges are permitted but are prohibited through ribs or beams without prior approval from the Architect.
- H. 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 complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

2.2 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com.
 2. Flexicraft Industries; PipeSeal: www.flexicraft.com.
 3. Jay R. Mfg. Co..
 4. Zurn Plumbing Products .
- B. 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 except where structural engineer has specifically approved location and method for drilled through openings.
- E. Structural Considerations:
 - 1. Do not penetrate building structural members unless indicated.
 - 2. All sleeves not already shown approved in structural drawing details shall be submitted to and approved by the structural engineer prior to fabrication..
- F. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
 - 2. Aboveground Piping:
 - a. Pack solid using mineral fiber complying with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch (15 mm) where penetrations occur between conditioned and unconditioned spaces.
 - 3. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.
 - 4. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- G. Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a water-tight seal.
 - 6. Install in accordance with manufacturer's recommendations.
- H. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.3 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.
- C. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

END OF SECTION

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SECTION 22 05 19
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 23 90 00 Energy Management and Control System
- B. Section 22 10 05 Plumbing Piping

1.3 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).
- C. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance 2012, with Addendum (2018).
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 for additional provisions.

1.5 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 ULTRAMAGNETIC WATER METERS

- A. Manufacturers:
 - 1. Onicon; www.onicon.com.
 - 2. Badger Meters; www.badgermeter.com.
 - 3. Substitutions: Division 1 for additional submittal requirements.
- B. Design - Sensing Technology: Ultrasonic flow sensing element shall utilize matched direct path, wetted ultrasonic transducers and 1000 OHM Platinum RTD.
- C. Construction: Flowmeter shall consist of a drop forged corrosion resistant metal flow body with process connections, integral transducers and a processor / transmitter. All wetted materials shall be NSF 372 compliant.
- D. Maximum Pressure Rating: 400psi
- E. Maximum Temperature Rating: 250F

- F. Mounting Connections: For NPS ½” – 2”, piping connections shall be male NPT threads; for NPS 2 ½” provide ANSI class flange, rated for maximum system temperature and pressure.
- G. Flow Range: Flow-measuring element and transmitter shall cover operating range of equipment or system served.
- H. Accuracy: Flowmeter shall provide calibrated outputs directly from the transmitter, throughout the operating range with the accuracy stated as follows:
 - 1. Plus or minus 1.0% of flow rate over a 25:1 turndown
 - 2. Plus or minus 2.0% of flow rate over a 100:1 turndown
- I. Transmitter: Transmitter shall provide instantaneous flow rate information over a 4-20mA scale and a pulse output for totalized flow information.
- J. Optional Transmitter with Integral Display and Operator Interface: Provide an operator interface consisting of three push-buttons. Display shall visually indicate total fluid volume, instantaneous flow rate and fluid temperature. Output signals shall be either serial network protocol, pulse output, analog output or combination. Pulse output for totalization of flow, Gallons typical. Optional serial communications output shall be native to the BTU meter, BACnet meters shall be BTL certified, secondary communication gateways shall not be permitted. Information provided via the serial communication network shall include: Flow rate, flow total, fluid temperature and a trend including peak values. Meters with serial communications shall be able to provide up to three additional auxiliary pulses configured as inputs or outputs.

2.2 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Moeller Instrument Company, Inc: www.moellerinstrument.com.
 - 3. Omega Engineering, Inc: www.omega.com.
 - 4. Substitutions: See Section 01 66 00 - Product Delivery, Storage and Handling.
- B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, liquid filled, 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 and kPa.

2.3 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa).

2.4 DIAL THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Omega Engineering, Inc: www.omega.com.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com.
 - 4. Substitutions: See Division 1.
- B. Thermometers - Adjustable Angle: Dial type bimetallic actuated; ASTM E1; stainless steel case, adjustable angle with front recalibration, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
 - 1. Size: 3 inch (75 mm) diameter dial.
 - 2. Accuracy: 1 percent.

3. Calibration: Degrees F.
4. Application: NSF labeled or approved for potable water systems.

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 flowmeters in accessible locations in piping systems based on manufacturer's recommendations regarding orientation and straight run requirements.
- C. Install flowmeter elements with at least the minimum straight lengths of pipe, upstream and downstream from meter, required to produce the published flowmeter accuracy according to manufacturer's written instructions.
- D. Install flow meters with full isolating valves on inlet and outlet to AWWA M6.
- E. Install gauges and thermometers in locations where they are easily read from normal operating level.
- F. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- G. Locate test plugs adjacent thermometers and thermometer sockets.

3.2 COMMISSIONING

- A. After installation, commission all meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility. Refer to manufacturers written instructions.

END OF SECTION

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SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- B. Section 22 10 05 - Plumbing 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: Non-rising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.
- H. 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 2017.
- 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. 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 2021.
- I. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- 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 2015.
- M. MSS SP-45 - Drain and Bypass Connections 2020.
- N. MSS SP-67 - Butterfly Valves 2017, with Errata.
- O. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends 2011.
- P. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.
- Q. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
- R. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
- S. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
- T. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided 2018.
- U. NSF 61 - Drinking Water System Components - Health Effects 2020.
- V. NSF 372 - Drinking Water System Components - Lead Content 2020.

1.5 SUBMITTALS

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

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

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.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

PART 2 PRODUCTS

2.1 APPLICATIONS

- A. See drawings for specific valve locations.
- B. Provide the following valves for the applications if not indicated on drawings:
 1. Shutoff: Ball, butterfly, gate or plug.

2. Swing Check (Pump Outlet):
 - a. 2 NPS (50 DN) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. 2-1/2 NPS (65 DN) and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.
 - c. 2-1/2 NPS (65 DN) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- C. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.
- D. Required Valve End Connections for Non-Wafer Types:
 1. Copper Tube:
 - a. 2 NPS (50 DN) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - b. 2-1/2 NPS (65 DN) to 4 NPS (100 DN): Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
- E. Domestic, Hot and Cold Water Valves:
 1. 2 NPS (50 DN) and Smaller:
 - a. Bronze and Brass: Provide with solder-joint or threaded ends.
 - b. Bronze Angle: Class 125, bronze disc.
 - c. Ball: One piece, full port, brass or bronze with brass trim.
 - d. Bronze Swing Check: Class 125, bronze disc.
 - e. Bronze Gate: Class 125, NRS.
 - f. Bronze Globe: Class 125, bronze disc.
 2. 2-1/2 NPS (65 DN) and Larger:
 - a. Iron, 2-1/2 NPS (65 DN) to 4 NPS (100 DN): Provide with threaded ends.
 - b. Iron Ball: Class 150.
 - c. Iron Single-Flange Butterfly: 200 CWP, EPDM seat, aluminum-bronze disc.
 - d. Iron Grooved-End Butterfly: 175 CWP.
 - e. Iron Swing Check: Class 125, metal seats.
 - f. Iron Swing Check with Closure Control: Class 125, lever and spring.
 - g. Iron Grooved-End Swing Check: 300 CWP.
 - h. Iron Center-Guided Check: Class 125, compact-wafer, metal seat.
 - i. Iron Plate-Type Check: Class 125; single plate; metal seat.
 - j. Iron Gate: Class 125, NRS.
 - k. Iron Globe: Class 125.

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:
- D. Valves in Insulated Piping: With 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. 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.
- F. General ASME Compliance:
 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 2. Solder-joint Connections: ASME B16.18.
 3. 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. Valve Bypass and Drain Connections: MSS SP-45.
- I. Source Limitations: Obtain each valve type from a single manufacturer.

2.3 BRONZE, BALL VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. One Piece, Reduced Port with Bronze Trim:
 1. Comply with MSS SP-110.
 2. SWP Rating: 400 psig (2760 kPa).
 3. CWP Rating: 600 psig (4140 kPa).
 4. Body: Bronze.
 5. Ends: Press.
 6. Seats: PTFE or TFE.
 7. Stem: Bronze.
 8. Ball: Chrome plated brass.
 9. Manufacturers:
 - a. Viega LLC: www.viega.us.
- C. Two Piece, Standard Port and Full Port with Bronze 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 or TFE.
 7. Stem: Bronze.
 8. Ball: Chrome plated brass.
 9. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.
 - b. Viega LLC: www.viega.us.
- D. Three 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: Bronze.
5. Ends: Threaded or press.
6. Seats: PTFE or TFE
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.
9. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.
 - b. Viega LLC: www.viega.us.

2.4 IRON, BALL VALVES

- A. Not needed, not Lead Free.
 1. Comply with MSS SP-72.
 2. CWP Rating: 200 psig (1380 kPa).
 3. Body: ASTM A536 Grade 65-45-12, ductile iron.
 4. Ends: Flanged.
 5. Seats: PTFE or TFE.
 6. Operator: Lever, with locking handle.

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: 200 psig (1380 kPa).
 3. Body: ASTM A126, cast iron or ASTM A536, ductile iron.
 4. Stem: One or two-piece stainless steel.
 5. Seat: EPDM.
 6. Disc: Stainless steel.

2.6 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 175 psig (1200 kPa).
 1. Comply with MSS SP-67, Type I.
 2. Body: Coated ductile iron.
 3. Stem: Two-piece stainless steel.
 4. Disc: Coated ductile iron.
 5. Disc Seal: EPDM.

2.7 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: CWP Rating: 200 psig (1380 kPa).
 1. Comply with MSS SP-80, Type 3.
 2. Design: Y-pattern, horizontal or vertical flow.
 3. Body: Bronze, ASTM B62.
 4. Ends: Threaded.
 5. Disc: Bronze.
 6. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.

2.8 IRON, HORIZONTAL SWING CHECK VALVES

A. Class 125:

1. Comply with MSS SP-71, Type I.
2. CWP Rating: 200 psig (1380 kPa).
3. Design: Clear or full waterway.
4. Body: ASTM A126, gray cast iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Composition.
7. Seat Ring and Disc Holder: Bronze.
8. Disc: PTFE or TFE.
9. Gasket: Asbestos free.
10. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Flomatic Valves; Flo-Flex Swing Check Valve: www.flomatic.com.

B. Class 250:

1. Comply with MSS SP-71, Type I.
2. CWP Rating: 500 psig (3450 kPa).
3. Design: Clear or full waterway.
4. Body: ASTM A126, gray iron with bolted bonnet.
5. Ends: Flanged as indicated.
6. Trim: Bronze.
7. Metal Seat.
8. Gasket: Asbestos free.

2.9 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125 with Lever and Spring-Closure Control.

1. Comply with MSS SP-71, Type I.
2. Description:
 - a. CWP Rating: 200 psig (1380 kPa).
 - b. Design: Clear or full waterway.
 - c. Body: ASTM A126, gray iron with bolted bonnet.
 - d. Ends: Flanged as indicated.
 - e. Trim: Bronze.
 - f. Gasket: Asbestos free.
 - g. Closer Control: Factory installed, exterior lever, and weight.
3. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.
 - b. Flomatic Valves; 90LS/92LS Swing Check Valve: www.flomatic.com.

2.10 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP:

1. CWP Rating: 300 psig (2070 kPa).
2. Body: ASTM A536, Grade 65-45-12 ductile iron.
3. Seal: EPDM
4. Disc: Ductile iron.
5. Coating: Black, non-lead paint.
6. Manufacturers:

- a. NIBCO Inc.

2.11 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Compact-Wafer:
1. Comply with MSS SP-125.
 2. CWP Rating: 200 psig (1380 kPa).
 3. Body: ASTM A126 gray iron.
 4. Body: 316 stainless steel.
 5. Metal Seat: Unleaded bronze.
 6. Metal Seat: Stainless steel.
 7. Resilient Seat: EPDM.
 8. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.
 - b. Flomatic Valves; 888S6R Wafer Check Valve: www.flomatic.com.
- B. Class 125, Globe:
1. Comply with MSS SP-125.
 2. CWP Rating: 200 psig (1380 kPa).
 3. Body: ASTM A126 gray iron.
 4. Body: Stainless steel.
 5. Style: Spring loaded.
 6. Ends: Flanged.
 7. Metal Seat: Unleaded bronze.
 8. Metal Seat: Stainless steel.
 9. Resilient Seat: EPDM.
 10. Manufacturers:
 - a. Flomatic Valves; 402S6R Globe Check Valve: www.flomatic.com.

2.12 BRONZE, GATE VALVES

- A. General:
1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Rising Stem (RS) or NRS:
1. Comply with MSS SP-80, Type I.
 2. Class 125: CWP Rating: 200 psig: (1380 kPa).
 3. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
 4. Ends: Threaded or solder joint joint.
 5. Stem: Bronze.
 6. Disc: Solid wedge; bronze.
 7. Packing: Asbestos free.
 8. Handwheel: Malleable iron, bronze, or aluminum.
 9. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.

2.13 IRON, GATE VALVES

- A. OS & Y or NRS:
1. Comply with MSS SP-70, Type I.
 2. Class 125: CWP Rating: 200 psig: (1380 kPa).
 3. Body: ASTM A126, gray iron with bolted bonnet.

4. Ends: Flanged.
5. Trim: Bronze.
6. Disc: Solid wedge.
7. Packing and Gasket: Asbestos free.
8. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.

2.14 BRONZE, GLOBE VALVES

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

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 and center-guided into horizontal or vertical position, between flanges.
- E. Provide chainwheels on operators for valves 4 NPS (100 DN) and larger where located 96 NPS (2400 DN) or more above finished floor, terminating 60 NPS (1520 DN) above finished floor.

END OF SECTION

**SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 50 00 - 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 2016a.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping 2014 (Reapproved 2020).
- 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 (2018).
- F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- 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 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.5 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

1.6 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. 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. Metal Channel (Strut) Framing Systems:
 - 1. Comply with MFMA-4.
 - 2. Channel Material:
 - a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
- C. 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 larger than 1 inch (27 mm) nominal: 3/8 inch (10 mm) diameter.
 - c. Trapeze Support for Multiple Pipes: 3/8 inch (10 mm) diameter.
- D. Thermal Insulated Pipe Supports:
 - 1. Manufacturers:
 - a. Buckaroos, Inc: www.buckaroos.com.
 - b. KB Enterprises: www.snappitz.com.
 - c. Substitutions: See Division 1.
 - 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).
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.
 - b. Substitutions: See Div 1.
- E. Pipe Supports:
 1. Manufacturers:
 - a. Carpenter & Paterson, Inc.
 - b. Clement Support Services.
 - c. Rilco Manufacturing Co. Inc.
 - d. Cooper B-Line or Tolco: www.eaton.com.
 - e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 2. 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.
 3. Operating Temperatures from 122 to 446 degrees F (50 to 230 degrees C):
 - 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.
- F. 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: www.anvilintl.com.
 - b. Cooper B-Line or Tolco: www.eaton.com.
 - c. Substitutions: See Division 1.
 - d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- G. 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.
 - b. Cooper B-Line or Tolco: www.eaton.com.
 - c. Substitutions: See Division 1.

- d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 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.
- H. Riser Clamps:
- 1. Manufacturers:
 - a. Ferguson Enterprises Inc: www.fnw.com.
 - b. Substitutions: See Division 1.
 - c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Provide copper plated clamps for copper tubing support.
 - 3. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- I. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- 1. Manufacturers:
 - a. Substitutions: See Division 1.
 - b. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- J. Strut Clamps: Two-piece pipe clamp.
- 1. Manufacturers:
 - a. Ferguson Enterprises Inc www.fnw.com.
 - b. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- K. Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- L. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
- 1. Manufacturers:
 - a. Ferguson Enterprises Inc: www.fnw.com.
 - b. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 3. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- M. Nonmetallic Pipe Hangers:
- 1. Manufacturers:
 - a. DecoShield Systems, Inc; Snap-2 Hangers: www.decoshield.com.
- N. Intermediate Pipe Guides: Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
- 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com.
 - b. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Pipe Diameter 6 inches (150 mm) and Smaller: Provide minimum clearance of 0.16 inch (4 mm).
 - 3. Pipe Diameter 8 inches (200 mm): Provide U-bolts with double nuts providing minimum clearance of 0.28 inch (7 mm).
 - 4. Pipe Diameter 8 inches (200 mm): 0.625 inch (16 mm) U-bolt.

5. Pipe Diameter 10 inches (250 mm): 0.75 inch (19 mm) U-bolt.
 6. Pipe Diameter 12 to 16 inches (300 to 400 mm): 0.875 inch (24 mm) U-bolt.
 7. Pipe Diameter 18 to 30 inches (450 to 750 mm): 1 inch (25 mm) U-bolt.
- O. Pipe Alignment Guides: Galvanized steel.
1. Manufacturers:
 - a. Anvil International www.anvilintl.com.
 - b. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 2. Pipe Diameter 8 inches (200 mm) and Smaller: Spider or sleeve type.
 3. Pipe Diameter 10 inches (250 mm) and Larger: Roller type.
 4. Pipe Diameter 18 to 30 inches (450 to 750 mm): 1 inch (25 mm) U-bolt.
- P. Pipe Shields for Insulated Piping:
1. Manufacturers:
 - a. Anvil International: www.anvilintl.com.
 - b. Substitutions: See Division 1.
 - c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 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.
- Q. Anchors and Fasteners:
1. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com.
 - c. Powers Fasteners, Inc: www.powers.com.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com.
 - e. Substitutions: See Division 1.
 2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.us.hilti.com.
 - b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com.
 - c. Powers Fasteners, Inc: www.powers.com.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com.
 - e. Substitutions: See Division 1.
 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. Powder-actuated fasteners are not permitted.

11. Hammer-driven anchors and fasteners are not permitted.
 12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
- R. Pipe Installation Accessories:
1. Copper Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - 2) Substitutions: See Division 1.
 - 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.
 2. Overhead Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - 2) Substitutions: See Division 1 See Section 01 66 00 - Product Delivery, Storage and Handling
 - 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.
 3. Plenum Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - 2) Substitutions: See Division 1.
 - 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.
 4. Inserts and Clamps:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - 2) Substitutions: See Division 1.
 - 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.

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. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners according to manufacturer's recommended torque settings.
- J. Remove temporary supports.

END OF SECTION

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SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Vibration isolators.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.3 DEFINITIONS

- A. Plumbing Component: Where referenced in this section in regards to seismic controls, applies to any portion of the plumbing system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., piping).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.4 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications Most Recent Edition Cited by Referring Code or Reference Standard.
- C. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment 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. Seismic Controls:
 - a. Coordinate the arrangement of seismic restraints with piping, conduit, equipment, and other potential conflicts installed under other sections or by others.
 - b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
 - 5. Notify Owner's rep 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 Division 3.

1.6 SUBMITTALS

- A. See Division 1 for submittal procedures.

- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
- D. Seismic Design Data:
 - 1. Include structural calculations, stamped or sealed by seismic controls designer, demonstrating suitability of seismic controls for seismic design forces.
- E. Evaluation Reports: For products specified as requiring evaluation and recognition by a qualified evaluation service, provide current evaluation reports.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Manufacturer's detailed field testing and inspection procedures.
- H. Field quality control test reports.

1.7 QUALITY ASSURANCE

- A. Comply with 2019 CBC.
- B. Seismic Controls Designer Qualifications: Registered professional engineer licensed in the State in which the Project is located and with minimum five years experience designing seismic restraints for nonstructural components.
 - 1. Designer may be employed by the manufacturer of the seismic restraint products.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 VIBRATION ISOLATION REQUIREMENTS

- A. Project applicability: Vibration isolation is only required for piping located above grade and these areas below.
 - 1. For all piping located above grade and 7' within Gridline e1.75.
 - 2. For condensate piping for the Admin Building, Class Lab 1, Class Lab 2 & Class Lab 3.
- B. Provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing plumbing equipment and/or plumbing connections to vibration-isolated equipment.
- C. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- D. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.

4. Select vibration isolators for outdoor equipment to comply with wind design requirements.

2.2 VIBRATION ISOLATORS

- A. Manufacturers:
 1. Vibration Isolators:
 - a. Kinetics Noise Control, Inc: www.kineticsnoise.com.
 - b. Mason Industries: www.mason-ind.com.
 - c. Vibration Eliminator Company, Inc: www.vec0-nyc.com.
 - d. Substitutions: See Division 1.
- B. Piping Isolation for Noise Control
 1. Isolate water piping from structure with HoldRite system products including but not limited to the following:
 - a. Thru-stud isolator/suspension clamps.
 - b. Neoprene waffle pads, 3/4" thick.
 - c. Isolation felt, min 1/4" thick.
 - d. Sound rated variable closure clampst with polymer isolator inserts.
 - e. Thru-wall pipe supports
- C. Do not allow direct pipe to structure contact.
- D. Support riser clamps on waffle pads
- E. For wet walls with a double wall between a restroom and noise sensitive spaces (office, library, classroom, etc.), mount piping only on the restroom wall framing, with no contact with the wall framing for the sensitive space(s).

2.3 ACOUSTICAL AND VIBRATION ISOLATORS

- A. Manufacturers:
 1. Acoustical and Vibration Isolators:
 - a. HoldRite : www.holdrite.com.
 - b. Mason Industries: www.mason-ind.com.
 - c. Substitutions: See Division 1.
- B. General Requirements:
 1. Acoustical Isolation System: Through-stud isolators, pipe clamps, riser clamp pads, neoprene and felt lining material and associated support brackets.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- 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. Secure fasteners according to manufacturer's recommended torque settings.
- D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

E. Vibration Isolation Systems:

1. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
2. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
3. Adjust isolators to be free of isolation short circuits during normal operation.
4. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

END OF SECTION

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe markers.
- E. Ceiling tacks.

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.

1.4 SUBMITTALS

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

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: Nameplates.
- G. Heat Transfer Equipment: Nameplates.
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Tags.
- 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. Brimar Industries, Inc www.pipemarker.com.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
 - 3. Seton Identification Products: www.seton.com.
 - 4. Substitutions: See Division 1.
- 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. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
 - 2. Brady Corporation www.bradycorp.com.
 - 3. Brimar Industries, Inc: www.pipemarker.com.
 - 4. Craftmark Pipe Markers: www.craftmarkid.com.
- 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 STENCILS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com.
 - 3. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
 - 4. Seton Identification Products: www.seton.com.
- B. Stencils: With clean cut symbols and letters of following size:
 - 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 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.

2.5 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com.

2. Brimar Industries, Inc: www.pipemarker.com.
 3. Craftmark Pipe Markers: www.craftmarkid.com.
 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
- 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. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.
- F. Color code as follows:
1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.

2.6 CEILING TACKS

- A. Manufacturers:
1. Craftmark Pipe Markers: www.craftmarkid.com.
 2. Substitutions: See Division 1.
- 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. Plumbing Valves: Green.
 4. 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 09 90 00 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 09 90 00.
- 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.
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

SECTION 22 07 19 PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including general and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 09 91 00 - Painting: Painting insulation jacket.

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 C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).
- E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement 2007 (Reapproved 2019).
- F. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- G. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation 2017.
- H. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2020a.
- I. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2019.
- J. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- L. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- M. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 101 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

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.

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

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation: www.knaufinsulation.com.
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com.
 - 5. Owens Corning Corporation; VaporWick Pipe Insulation: www.ocbuildingspec.com.
- 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. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. K (Ksi) Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
 - 2. Maximum Service Temperature: 650 degrees F (343 degrees C).
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- E. 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).
- F. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
- G. Vapor Barrier Lap Adhesive: Compatible with insulation.
 - 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc.
- H. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc.
- I. Fibrous Glass Fabric:
 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc.
 2. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 3. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
 4. Weave: 5 by 5.
- J. Indoor Vapor Barrier Finish:
 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc.
 - b. Substitutions: See Section 01 66 00 - Product Delivery, Storage and HandlingSee Division 1.
- K. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc.
 - b. Substitutions: See Section 01 66 00 - Product Delivery, Storage and HandlingSee Division 1.
- L. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc.
 - b. Substitutions: See Section 01 66 00 - Product Delivery, Storage and HandlingSee Division 1.
- M. Insulating Cement: ASTM C449.
 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc.
 - b. Substitutions: See Section 01 66 00 - Product Delivery, Storage and HandlingSee Division 1.

2.3 HYDROUS CALCIUM SILICATE

- A. Manufacturers:
 1. Johns Manville Corporation: www.jm.com.
 2. Substitutions: See Division 1See Section 01 66 00 - Product Delivery, Storage and Handling.
- B. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
 1. K (Ksi) Value: 0.40 at 300 degrees F (0.057 at 149 degrees C) when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 1200 degrees F (649 degrees C).
 3. Density: 15 lb/cu ft (240 kg/cu m).

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 1. Aeroflex USA, Inc; Aerocel Stay-Seal with Protape (SSPT): www.aeroflexusa.com.
 2. Armacell LLC; AP Armaflex: www.armacell.us.
 3. K-Flex USA LLC; Insul-Tube: www.kflexusa.com.

- 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: 220 degrees F (104 degrees C).
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.5 JACKETS

- A. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch (0.40 mm) sheet.
 - 2. Finish: smooth or embossed.
 - 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.

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. 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. 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.
- H. 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.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
 - J. 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.
 - K. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
 - L. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 SCHEDULES

- A. Plumbing Systems:
 1. Domestic Hot Water Supply:
 - a. Glass Fiber Insulation:
 - 1) Thickness: 1 inch (25.4 mm).
 - b. Cellular Foam Insulation:
 - 1) Thickness: 1 inch (25.4 mm).

END OF SECTION

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SECTION 22 10 05 PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Sanitary sewer.
 - 2. Domestic water.
 - 3. Storm water.
 - 4. Flanges, unions, and couplings.
 - 5. Manufactured sleeve-seal systems.
 - 6. Valves.
 - 7. Strainers.

1.2 RELATED REQUIREMENTS

- A. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building
- B. Section 08 31 00 - Access Doors and Panels.
- C. Section 09 90 00 Painting
- D. Section 22 05 16 - Flexible Fittings for Plumbing Piping.
- E. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- F. Section 31 23 33 - Trenching, Backfilling and Compacting.

1.3 REFERENCE STANDARDS

- A. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV 2021.
- B. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DWV 2017.
- C. ASME B31.9 - Building Services Piping 2020.
- D. 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 2021.
- E. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Potable Water Distribution Systems 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 B306 - Standard Specification for Copper Drainage Tube (DWV) 2020.
- I. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube 2016.
- J. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings 2016.
- K. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.
- L. AWWA C550 - Protective Interior Coatings for Valves and Hydrants 2017.
- M. AWWA C651 - Disinfecting Water Mains 2014, with Addendum (2020).

- N. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications 2018.
- O. NSF 61 - Drinking Water System Components - Health Effects 2020.
- P. NSF 372 - Drinking Water System Components - Lead Content 2020.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Shop Drawings: For the purposes of coordinating architectural aesthetics, submit shop drawings including 1/48th scale plans and elevations for the following areas:
 - 1. Indoor sinks with sediment traps below counter including drainage and water systems.
 - 2. Outdoor wall mounted sinks with sediment traps below counter including drainage and water systems.
 - 3. Water heaters showing clearances are being provided with relation to all other nearby trades.
- D. Project Record Documents: Record actual locations of valves.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. 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.

2.2 SANITARY SEWER PIPING, BURIED BEYOND 5 FEET (1500 MM) OF BUILDING

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

2.3 SANITARY SEWER 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.

2.4 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
 1. Fittings: Cast iron.
 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. 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.
- C. ABS Pipe: ASTM F628 (GREENHOUSE VENT PIPE ONLY).
 1. Fittings: ABS.
 2. Joints: Solvent welded with ASTM D2235 cement.
- D. ABS Pipe: ASTM D2661 (GREENHOUSE VENT PIPE ONLY).
 1. Fittings: ABS.
 2. Joints: Solvent welded with ASTM D2235 cement.

2.5 DOMESTIC WATER PIPING, BURIED BEYOND 5 FEET (1500 MM) OF BUILDING

- A. Copper Pipe: ASTM B42, hard drawn.
 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
 2. Joints: ASTM B32, alloy Sn95 solder.
 3. Joints: AWS A5.8M/A5.8, BCuP copper/silver braze.
- B. Copper Pipe: ASTM B42, annealed.
 1. Fittings: ASME B16.26, cast bronze.
 2. Joints: Flared.

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

- A. Copper Pipe: ASTM B42, hard drawn.
 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
 2. Joints: ASTM B32, alloy Sn95 solder.
 3. Joints: AWS A5.8M/A5.8, BCuP copper/silver braze.
- B. Copper Pipe: ASTM B42, annealed.
 1. Fittings: ASME B16.26, cast bronze.
 2. Joints: Flared.
 3. Manufacturers:
 - a. Uponor, Inc: www.uponorengineering.com.
 - b. Substitutions: See Div 1.
 4. PPI TR-4 Pressure Design Basis:
 - a. 160 psig (1102 kPa) at maximum 73 degrees F (23 degrees C).
 - b. 100 psig (689 kPa) at maximum 180 degrees F (82 degrees C).
 - c. 80 psig (551 kPa) at maximum 200 degrees F (93 degrees C).
 5. Fittings: Brass and engineered polymer (EP) ASTM F1960.
 6. Joints: ASTM F1960 cold-expansion fittings.

2.7 DOMESTIC WATER PIPING, ABOVE GRADE

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

4. Joints: Grooved mechanical couplings.
5. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Anvil International: www.anvilintl.com.
 - 2) Apollo Valves: www.apollovalves.com.
 - 3) Grinnell Products: www.grinnell.com.
 - 4) Viega LLC: www.viega.us.
 - 5) Substitutions: See Division 1.

2.8 STORM WATER PIPING, BURIED BEYOND 5 FEET (1500 MM) OF BUILDING

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

2.9 STORM WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

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

2.10 STORM WATER 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.
- B. Copper Tube: ASTM B306, DWV.
 1. Fittings: ASME B16.23, cast copper, or ASME B16.29, wrought copper.
 2. Joints: ASTM B32, alloy Sn50 solder.

2.11 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches (80 mm) and Under:
 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
 2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Size Over 1 Inch (25 mm):
 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- 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. Housing Material: Provide ASTM A47/A47M malleable iron or ductile iron, galvanized.
 3. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
 4. Gasket Material: Nitrile rubber suitable for operating temperature range from minus 20 degrees F to 180 degrees F (minus 29 degrees C to 82 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. Anvil International www.anvilintl.com.

- b. Apollo Valves: www.apollovalves.com.
 - c. Grinnell Products www.grinnell.com.
 - d. Substitutions: See Division 1.
- D. No-Hub Couplings:
- 1. Gasket Material: Neoprene complying with ASTM C564.
 - 2. Band Material: Stainless steel.
 - 3. Eyelet Material: Stainless steel.
 - 4. Manufacturers:
 - a. MIFAB, Inc: www.mifab.com.
 - b. Substitutions: See Division 1.

2.12 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.

2.13 BALL VALVES

- A. Manufacturers:
- 1. Anvil International: www.anvilintl.com.
 - 2. Apollo Valves: www.apollovalves.com.
 - 3. Grinnell Products: www.grinnell.com.
 - 4. Nibco, Inc: www.nibco.com.
- B. Construction, 4 Inches (100 mm) and Smaller: MSS SP-110, Class 150, 400 psi (2760 kPa) CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.14 BUTTERFLY VALVES

- A. Manufacturers:
- 1. Anvil International: www.anvilintl.com.
 - 2. Apollo Valves: www.apollovalves.com.
 - 3. Crane Company: www.cranecpe.com.
 - 4. Grinnell Products; B302: www.grinnell.com.
- B. Construction 1-1/2 Inches (40 mm) and Larger: MSS SP-67, 200 psi (1380 kPa) CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.
- C. Provide gear operators for valves 8 inches (150 mm) and larger, and chain-wheel operators for valves mounted over 8 feet (2400 mm) above floor.

2.15 PIPING SPECIALTIES

- A. Flow Controls:
- 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com.
 - b. ITT Bell & Gossett: www.bellgossett.com.
 - c. Griswold Controls: www.griswoldcontrols.com.
 - d. Taco, Inc: www.taco-hvac.com.

- e. Substitutions: See Div 1.
- 2. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- 3. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi (24 kPa).

2.16 WATER PRESSURE REDUCING VALVES

- A. Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com.
 - 2. Apollo Valves: www.apollovalves.com.
 - 3. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com.
 - 4. Substitutions: See Div 1.
- B. Up to 2 Inches (50 mm):
 - 1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
- C. Over 2 Inches (50 mm):
 - 1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.17 RELIEF VALVES

- A. Pressure:
 - 1. Manufacturers:
 - a. Cla-Val Co: www.cla-val.com.
 - b. Henry Technologies: www.henrytech.com.
 - c. Watts Regulator Company: www.wattsregulator.com.
 - d. Substitutions: See Division 1.
 - 2. ANSI Z21.22, AGA certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.
- B. Temperature and Pressure:
 - 1. Manufacturers:
 - a. Cla-Val Co: www.cla-val.com.
 - b. Watts Regulator Company: www.wattsregulator.com.
 - c. Substitutions: See Division 1.
 - 2. ANSI Z21.22, AGA certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F (98.9 degrees C), capacity ASME BPVC-IV certified and labelled.

2.18 STRAINERS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com.
 - 2. Green Country Filter Manufacturing: www.greencountryfilter.com.
 - 3. WEAMCO: www.weamco.com.
 - 4. Substitutions: See Division 1.
- B. Size 2 Inches (50 mm) and Under:
 - 1. Threaded brass body for 175 psi (1200 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
 - 2. Class 150, threaded bronze body 300 psi (2070 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.

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. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
 - 1. Coordinate size and location of access doors with Section 08 31 00.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
- J. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
 - 1. See Section 09 90 00 for painting of plumbing systems and components.
- K. Excavate in accordance with Section 31 23 16.
- L. Backfill in accordance with Section 31 23 23.
- M. Install bell and spigot pipe with bell end upstream.
- N. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 05 23.
- O. Install water piping to ASME B31.9.
- P. 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.
- Q. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- R. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.
 - 3. Provide copper plated hangers and supports for copper piping.

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

3.4 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install globe or characterized ball valves for throttling, bypass, or manual flow control services.
- D. Provide spring-loaded check valves on discharge of water pumps.

3.5 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch (10 mm) vertically of location indicated and slope to drain at minimum of 1/4 inch per foot (1:50) slope. Slopes of 1/8 inch per foot (1:100) is allowed for pipes oversized per allowance in CPC.
- B. Water Piping: Slope at minimum of 1/32 inch per foot (1:400) and arrange to drain at low points.

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 SCHEDULES

- A. Pipe Hanger Spacing:
 1. Metal Piping:

- a. Pipe Size: 1/2 inches (15 mm) to 1-1/4 inches (32 mm):
 - 1) Maximum Hanger Spacing: 6.5 ft (2 m).
 - 2) Hanger Rod Diameter: 3/8 inches (9 mm).
 - b. Pipe Size: 1-1/2 inches (40 mm) to 2 inches (50 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 3/8 inch (9 mm).
 - c. Pipe Size: 2-1/2 inches (65 mm) to 3 inches (75 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 1/2 inch (13 mm).
 - d. Pipe Size: 4 inches (100 mm) to 6 inches (150 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 5/8 inch (15 mm).
2. Plastic Piping:
- a. All Sizes:
 - 1) Maximum Hanger Spacing: 6 ft (1.8 m).
 - 2) Hanger Rod Diameter: 3/8 inch (9 mm).

END OF SECTION

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**SECTION 22 10 06
PLUMBING PIPING SPECIALTIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Drains.
- B. Cleanouts.
- C. Hose bibbs.
- D. Hydrants.
- E. Refrigerator valve and recessed box.
- F. Backflow preventers.
- G. Double check valve assemblies.
- H. Water hammer arrestors.
- I. Sanitary waste interceptors.
- J. Mixing valves.

1.2 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping.
- B. Section 22 30 00 - Plumbing Equipment.
- C. Section 22 40 00 - Plumbing Fixtures.
- D. Division 26: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers 2017.
- B. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent 2021.
- C. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies 2021.
- D. NSF 61 - Drinking Water System Components - Health Effects 2020.
- E. NSF 372 - Drinking Water System Components - Lead Content 2020.
- F. PDI-WH 201 - Water Hammer Arresters 2017.

1.4 SUBMITTALS

- A. See Section 01 30 00 - 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. Operation Data: Indicate frequency of treatment required for interceptors.
- E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

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

1.6 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 DRAINS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 - 2. Josam Company: www.josam.com.
 - 3. Zurn Industries, LLC: www.zurn.com.
 - 4. Substitutions: See Division 1.
- B. Roof Drains:
 - 1. Body: Lacquered cast iron with sump.
 - 2. Strainer: Removable polyethylene dome with vandal proof screws.
 - 3. Accessories: Coordinate with roofing type, refer to roofing systems section(s):
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Roof sump receiver.
 - d. Waterproofing flange.
 - e. Leveling frame.
 - f. Provide o-ring seal between male and female connection pipes.
 - 4. Manufacturers:
 - a. Jay R. Smith Manufacturing Company; [____]: www.jrsmith.com.
 - b. Menzies Metal Products; Clamp-Tite Spun Aluminum Drain (Small Bowl)www.menzies-metal.com.
 - c. MIFAB, Inc; [____]: www.mifab.com.
 - d. Substitutions: See Div 1.
- C. Parapet Drains:
 - 1. Lacquered cast iron body with aluminum flashing clamp collar and epoxy coated sloping grate.
- D. Downspout Nozzles:
 - 1. Bronze or aluminum round with flush flapper door.
- E. Floor Drain:
 - 1. Dura-Coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with seepage slots and "TYPE B" stainless steel, light-duty strainer.
- F. Floor Drain:
 - 1. Dura-Coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with seepage slots and "TYPE BL" D.C.C.I. wide flanged head and stainless steel, light-duty strainer.

2.3 CLEANOUTS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company www.jayrsmith.com.
 - 2. Josam Company: www.josam.com.
 - 3. MIFAB, Inc: www.mifab.com.
 - 4. Zurn Industries, LLC: www.zurn.com.

5. Substitutions: See Section 01 66 00 - Product Delivery, Storage and Handling See Division 1.
- B. Cleanouts at Exterior Surfaced Areas :
 1. Round cast nickel bronze access frame and non-skid cover.
- C. Cleanouts at Exterior Unsurfaced Areas :
 1. Line type with lacquered cast iron body and round epoxy coated gasketed cover.
- D. Cleanouts at Interior Finished Floor Areas :
 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.
- E. Cleanouts at Interior Finished Wall Areas :
 1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
- F. Cleanouts at Interior Unfinished Accessible Areas (CO-5): Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.4 HOSE BIBBS

- A. Manufacturers:
 1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 2. Murdock Manufacturing, Inc: www.murdockmfg.com.
 3. Watts Regulator Company: www.wattsregulator.com.
 4. Zurn Industries, LLC: www.zurn.com.
 5. Substitutions: See Div 1.
- B. Interior Hose Bibbs:
 1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with handwheel, integral vacuum breaker in compliance with ASSE 1011.

2.5 HYDRANTS

- A. Manufacturers:
 1. Arrowhead Brass & Plumbing, LLC: www.arrowheadbrass.com.
 2. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 3. Murdock Manufacturing, Inc: www.murdockmfg.com.
 4. Zurn Industries, LLC: www.zurn.com.
 5. Substitutions: See Div 1.
- B. Wall Hydrants:
 1. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate hose thread spout, handwheel, and integral vacuum breaker.
- C. Floor Hydrants:
 1. ASSE 1019; chrome plated lockable recessed box, hose thread spout, lockshield and removable key, and vacuum breaker.

2.6 REFRIGERATOR VALVE AND RECESSED BOX

- A. Box Manufacturers:
 1. IPS Corporation/Water-Tite: www.ipscorp.com.
 2. Oatey Supply Chain Services, Inc. www.oatey.com.
 3. Viega LLC: www.viega.us.
 4. Substitutions: See Div 1.

- B. Valve Manufacturers:
 - 1. IPS Corporation/Water-Tite: www.ipscorp.com.
 - 2. Viega LLC: www.viega.us.
 - 3. Zurn Industries, LLC: www.zurn.com.
 - 4. Substitutions: See Div 1.

2.7 BACKFLOW PREVENTERS

- A. Manufacturers:
 - 1. Apollo Valves; [_____]: www.apollovalves.com.
 - 2. MIFAB, Inc; [_____]: www.mifab.com.
 - 3. Watts Regulator Company, a part of Watts Water Technologies; [_____]
: www.wattsregulator.com.
 - 4. Zurn Industries, LLC; [_____]: www.zurn.com.
 - 5. Substitutions: See Div 1.
- B. Reduced Pressure Backflow Preventers:
 - 1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.8 DOUBLE CHECK VALVE ASSEMBLIES

- A. Manufacturers:
 - 1. Apollo Valves; [_____]: www.apollovalves.com.
 - 2. Watts Regulator Company, a part of Watts Water Technologies; [_____]
: www.wattsregulator.com.
 - 3. Zurn Industries, LLC; [_____]: www.zurn.com.
 - 4. Substitutions: See Div 1.
- B. Double Check Valve Assemblies:
 - 1. ASSE 1012; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

2.9 WATER HAMMER ARRESTORS

- A. Manufacturers:
 - 1. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com.
 - 2. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 - 3. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
 - 4. Zurn Industries, LLC: www.zurn.com.
 - 5. Substitutions: See Section 01 66 00 - Product Delivery, Storage and Handling See Division 1.
- B. Water Hammer Arrestors:
 - 1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F (minus 73 to 149 degrees C) and maximum 250 psi (1700 kPa) working pressure.

2.10 SANITARY WASTE INTERCEPTORS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company: www.jrsmith.com.

2. MIFAB, Inc: www.mifab.com.
 3. Zurn Industries, LLC: www.zurn.com.
- B. Grease Interceptors:
1. Construction:
 - a. Material: Precast concrete.
 - b. Rough-in: Fully buried; provide balast slab and tie-down where required my manufacturer for site soil geotechnical conditions.
 - c. Accessories: Multi-weir baffle assembly, integral deep seal trap, removable integral flow control, vehicular rated when installed in vehicle travel paths.
 - d. Cover: Steel, epoxy coated, non-skid with gasket, securing handle, and enzyme injection port, recessed for floor finish.

2.11 MIXING VALVES

- A. Thermostatic Mixing Valves:
1. Manufacturers:
 - a. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com.
 - b. ESBE: www.esbe.se/en.
 - c. Honeywell International Inc: www.honeywellhome.com.
 - d. Leonard Valve Company: www.leonardvalve.com.
 - e. Substitutions: See Section 01 66 00 - Product Delivery, Storage and HandlingSee Division 1.
 2. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
 3. Accessories:
 - a. Check valve on inlets.
 - b. Volume control shut-off valve on outlet.
 - c. Stem thermometer on outlet.
 - d. Strainer stop checks on inlets.
 4. Cabinet: 16 gauge, 0.0598 inch (1.52 mm) prime coated steel, for recessed mounting with keyed lock.

2.12 RELIEF VALVES

- A. Manufacturers:
1. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com.
 2. ITT Bell & Gossett: www.bellgossett.com.
 3. Substitutions: See Division 1.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.13 AIR VENTS

- A. Manufacturers:
1. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com.
 2. ITT Bell & Gossett: www.bellgossett.com.
 3. Substitutions: See Division 1.
- B. 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.

2.14 FLOOR DRAIN TRAP SEALS

- A. Manufacturers:
1. MIFAB, Inc: www.mifab.com.

2. Precision Plumbing Products: www.pppinc.net.
 3. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
- B. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. 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.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- F. Pipe relief from backflow preventer to nearest drain.
- G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks or water closets.
- H. Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch (20 mm) minimum, and minimum 18 inches (450 mm) long.

END OF SECTION

SECTION 22 30 00 PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water Heaters:
 - 1. Residential electric.
 - 2. Commercial electric.
 - 3. Tankless electric.
- B. Diaphragm-type compression tanks.

1.2 RELATED REQUIREMENTS

- A. Division 26: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2021.
- B. 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 01 30 00 - Administrative Requirements, for submittals procedures.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Indicate pump type, capacity, power requirements.
 - 3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 4. Provide electrical characteristics and connection requirements.
- C. Shop Drawings:
 - 1. Indicate water heater dimensions, maintenance clearances, size of tapings, and performance data.
- D. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- F. Project Record Documents: Record actual locations of components.

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. Certifications:
 - 1. Water Heaters: NSF approved.
 - 2. Electric Water Heaters: UL listed and labeled to UL 174.
 - 3. 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. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 WARRANTY

- A. See Section 01 77 00 - Contract Closeout and Final Cleaning, for additional warranty requirements.
- B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.1 WATER HEATERS

- A. Manufacturers:
 - 1. A.O. Smith Water Products Co: www.hotwater.com.
 - 2. Rheem Manufacturing Company: www.rheem.com.
 - 3. Hubbell: www.hubbellheaters.com.
 - 4. Substitutions: See Division I See Section 01 66 00 - Product Delivery, Storage and Handling.
- B. Tankless Electric:
 - 1. Type: Automatic, electric.
 - 2. Performance:
 - a. See plans for capacities and amperage.
 - b. Maximum Working Pressure: 150 psig (1000 kPa).
 - 3. Electrical Characteristics:
 - a. 208 volts, single phase (see plans for where occurs).
 - b. [208] volts, three phase (see plans for where occurs).
 - 4. Controls: Automatic water thermostat with externally adjustable temperature range from 120 to 170 degrees F (49 to 77 degrees C), flanged or screw-in nichrome elements, enclosed controls and electrical junction box and operating light.
 - 5. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Brass.
 - c. Drain valve.
 - d. Anode: Magnesium.
 - e. Temperature and Pressure Relief Valve: ASME labeled.
- C. Air Source Heat Pump Water Heaters
 - 1. Type: Field-assembled and wired, electric, split system heat pump with physically separate outdoor condenser and indoor storage tank with internal heat exchanger and refrigerant piping between the two units.
 - 2. Performance:
 - a. Energy Factor: 3.75.
 - b. Storage Capacity: 83 gal.
 - c. First Hour Rating: 115 gallons.
 - d. Nominal heating capacity: 15,4000 BTUH (4.5kW).
 - e. Maximum Working Pressure: 150 psig (1000 kPa).
 - 3. Electrical Characteristics:
 - a. 208 volts, single phase, 60 Hz.
 - 4. Tank: Glass lined welded steel; thermally insulated with minimum 2 inches (50 mm) glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.
 - 5. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Brass.
 - c. Drain valve.

- d. Anode: Magnesium.
- e. Temperature and Pressure Relief Valve: ASME labeled.

2.2 DIAPHRAGM-TYPE COMPRESSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com.
 - 2. Bell & Gossett, a xylem brand: www.bellgossett.com.
 - 3. Taco, Inc: www.taco-hvac.com.
 - 4. Substitutions: See Div 1.
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig (80 kPa).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping and related electrical work to achieve operating system.
- C. Domestic Water Storage Tanks:
 - 1. Provide steel pipe support, independent of building structural framing members.
 - 2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

END OF SECTION

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SECTION 22 40 00 PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water closets.
- B. Urinals.
- C. Lavatories.
- D. All-in-one lavatory system.
- E. Sinks.
- F. Mop sinks.
- G. Electric water coolers.
- H. Drinking fountains.
- I. Eye and face wash fountains.

1.2 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping.
- B. Section 22 10 06 - Plumbing Piping Specialties.
- C. Section 22 30 00 - Plumbing Equipment.
- D. Division 26: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment 2014.
- C. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration 2008 (Reaffirmed 2013).
- D. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use 1997 (Reaffirmed 2017).
- E. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
- F. ASME A112.19.2 - Ceramic Plumbing Fixtures 2018, with Errata.
- G. ASME A112.19.3 - Stainless Steel Plumbing Fixtures 2017, with Errata.
- H. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices 2020.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- J. IAPMO Z124 - Plastic Plumbing Fixtures 2017, with Errata.
- K. NSF 61 - Drinking Water System Components - Health Effects 2020.
- L. NSF 372 - Drinking Water System Components - Lead Content 2020.
- M. UL (DIR) - Online Certifications Directory Current Edition.

1.4 SUBMITTALS

- A. See Section 01 30 00 - 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. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 66 00 - Product Delivery, Storage and Handling, for additional provisions.
 - 2. Extra Faucet Washers: One set of each type and size.
 - 3. Extra Toilet Seats: One of each type and size.
 - 4. Flush Valve Service Kits: One for 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.

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 01 77 00 - Contract Closeout and Final Cleaning, 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 FLUSH VALVE WATER CLOSETS

- A. Water Closets: Vitreous china, ASME A112.19.2, floor mounted, siphon jet flush action, china bolt caps.
 - 1. Flush Valve: Exposed (top spud).
 - 2. Flush Operation: Manual, oscillating handle.
 - 3. Handle Height: 44 inches (1117 mm) or less.
 - 4. Manufacturers:
 - a. American Standard, Inc: www.americanstandard-us.com.

- b. Kohler Company: www.kohler.com.
 - c. Toto: www.totousa.com.
 - d. Zurn Industries, Inc: www.zurn.com.
- 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, solar powered, infrared sensor with mechanical over-ride or over-ride push button.
 - 2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
 - 3. Manufacturers:
 - a. Sloan Valve Company: www.sloanvalve.com.
 - b. Kohler: www.kohler.com.
 - c. Toto: www.totousa.com.
 - d. Zurn Industries, Inc: www.zurn.com.
 - e. Substitutions: See Division 1.
- C. Seats:
- 1. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, with cover.
- D. Water Closet Carriers:
- 1. Manufacturers:
 - a. Jay R. Smith MFG. Co: www.jrsmith.com.
 - b. JOSAM Company: www.josam.com.
 - c. Zurn Industries, Inc: www.zurn.com.
 - d. Substitutions: See Div 1.
 - 2. ASME A112.6.1M; adjustable cast iron 500 pound frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.4 WALL HUNG URINALS

- A. Wall Hung Urinal Manufacturers:
- 1. American Standard, Inc: www.americanstandard-us.com.
 - 2. Gerber Plumbing Fixtures LLC: www.gerberonline.com.
 - 3. Kohler Company: www.kohler.com.
 - 4. Toto: www.totousa.com.
 - 5. Viega LLC: www.viega.us.
 - 6. Zurn Industries, Inc; EcoVantage Z5798 High-Efficiency Urinal System: www.zurn.com.
 - 7. Substitutions: See Div 1.
- B. Urinals: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
- 1. Flush Volume: 0.125 gallons (0.47 liters), maximum.
 - 2. Flush Valve: Exposed (top spud).
 - 3. Flush Operation: Sensor operated.
 - 4. Trap: Integral.
- 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, solar powered, infrared sensor with mechanical over-ride or over-ride push button.
 - 2. Manufacturers:
 - a. American Standard, Inc: www.americanstandard-us.com.
 - b. Sloan Valve Company: www.sloanvalve.com.

- c. Toto: www.totousa.com.
 - d. Zurn Industries, Inc: www.zurn.com.
 - e. Substitutions: See Div 1.
- D. Carriers:
- 1. Manufacturers:
 - a. Jay R. Smith MFG. Co: www.jrsmith.com.
 - b. JOSAM Company: www.josam.com.
 - c. Viega LLC: www.viega.us.
 - d. Zurn Industries, Inc: www.zurn.com.
 - e. Substitutions: See Div 1.
 - 2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.5 WALL-HUNG MULTI-STATION LAVATORY UNITS - SOLID SURFACE

- A. Description: Rectilinear, level-surface deck, seamless and integral elongated basin, with stainless steel enclosed pedestal cabinet.
- B. Deck and Bowl Material: Fabricate from molded engineered stone material consisting of natural quartz, granite, and other minerals in a matrix of thermoset acrylic modified bio-based polyester resin and meeting requirements of IAPMO Z124.
- C. Surface Burning Characteristics: Smoke developed index less than 450, and flame spread index less than 25, Class A, when tested in accordance with ASTM E84.
- D. Number of Wash Stations: One or Two, see plans and equipment schedule.
- E. Unit Length: see plans and equipment sche.
- F. Soap Dispenser:
 - 1. Deck-mounted, sensor-operated, chrome-plated plastic, with LED battery and soap level indicators, battery box and batteries and 27 ounce (798 ml) bottle of 1000 shot soap.
- G. Water Supply: Thermostatic mixing valve assembly.
- H. Color: As selected by Architect from manufacturer's full line.
- I. Faucet Drilling: 4 inch (100 mm) centerset drilling.
- J. Sensor-Operated Faucets:
 - 1. High profile metering faucet with infrared and external temperature control.
 - 2. Vandal-resistant meeting requirements of ASME A112.18.1 and ADA Standards compliant.
 - 3. Body: Polished chrome plated commercial solid cast brass, with 4 inch (102 mm) centerset mounting with anti-rotation trim plate.
 - 4. Tempered Water Supply: ADA Standards compliant lever on faucet body.
 - 5. Aerator: Flow rate of 0.35 gal/min (1.32 L/s) at an operating range of 20 to 80 psi (138 to 552 kPa).
 - 6. Sensor Module: Water conserving, vandal-resistant adjustable sensor unit with timing turn-off delay and stationary object automatic timed cutoff, with battery diagnostic light, serviceable from above deck.
 - 7. Power Supply: Battery-operated single faucet with 6V lithium battery and single 115 VAC plug-in adapter.
 - 8. Thermostatic Mixing Valve: Thermostatic mixing valve, ASSE 1070 listed, with combination stop, strainer, and check valves, and flexible stainless steel connectors.
- K. Access Panel: integrated into lower integrated enclosure.

- L. Support Frame: Wall mounted, heavy gauge, stainless steel Z-brackets.
- M. Manufacturers:
 - 1. Sloan Valve Company: www.sloanvalve.com.
 - 2. Substitutions: See Division 1.

2.6 ALL-IN-ONE LAVATORY SYSTEM

- A. Manufacturers:
 - 1. Sloan Valve Company: www.sloanvalve.com.
 - 2. Substitutions: See Div 1
- B. Wall-Mounted Integrated Lavatory Unit: Formed from molded solid surface material with integral bowl, wall mounting frame, built-in faucet, built-in soap dispenser, and hand dryer.
- C. Bowl and Deck Material:
 - 1. Fabricate from bio-based resin and preconsumer recycled granules with minimum 25 percent preconsumer recycled content and 8 percent bio-based resins, solid surface material, certified by an approved independent testing agency and meeting requirements of IAPMO Z124.
- D. Faucet:
 - 1. Built-in vandal-resistant, low profile faucet, formed from chrome coated solid brass, with low-voltage sensor using a zone-focused, hand-detecting, infrared, transmitting beam and timed, turn-off delay.
 - 2. Flow Rate: Not greater than 0.38 gal/min (1.44 L/s).
 - 3. Solenoid Valve: 24 V, 50/60 Hz, electronically-activated, equipped with flow regulator and plug-in transformer.
 - 4. Thermostatic Mixing Valve: ASSE 1070 listed and NSF 372 compliant. Provide with check valves, and flexible, stainless steel connectors.
- E. Hand Dryer:
 - 1. Energy-efficient UL listed dryer unit with low-voltage, hand-detecting infrared sensor, integrated into lavatory deck, with LED-illuminated dryer cavity and anti-microbial dryer nozzles.
 - 2. Noise Level: 80 db at 69 to 70 cu ft/min (32 to 33 L/s).
 - 3. Run Time: Variable.
 - 4. Typical Drying Time: 15 seconds.
 - 5. Power Supply: 120/60 volts, 1150 watts, 12 amps with 36 inch (914 mm) power cord with plug end.
- F. Liquid Soap Dispenser:
 - 1. Built-in vandal-resistant, low profile electronic dispenser formed from composite fiberglass-reinforced polymer with painted, clear-coat finish, with low-voltage hand-detecting infrared sensor, activation rate control, and overflow fill protection.
 - 2. Top filled from tamper-resistant cover.
 - 3. Capacity: 64 ounce (1.89 L).

2.7 KITCHEN SINKS

- A. Sink Manufacturers:
 - 1. American Standard, Inc: www.americanstandard-us.com.
 - 2. Kohler Company: www.kohler.com.
 - 3. Elkay: www.elkay.com
 - 4. Substitutions: See Division 1.

- B. Single Compartment Bowl: 20 gauge, 0.0359 inch (0.91 mm) thick, Type 302 stainless steel; see plans and fixture schedule for dimensions, mounting styles and hole patterns required for each location.
 - 1. Drain: 3-1/2 inch (90 mm) SS screen cup and tailpiece.

2.8 BI-LEVEL, ELECTRIC WATER COOLERS

- A. Bi-level, Electric Water Cooler Manufacturers:
 - 1. Elkay Manufacturing Company: www.elkay.com.
 - 2. Haws Corporation: www.hawesco.com.
 - 3. Oasis International: www.oasiscoolers.com.
 - 4. Substitutions: See Div 1.
- B. Water Cooler: Bi-level, electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.
 - 1. Capacity: 8 gallons per hour (30.3 liters per hour) of 50 degrees F (10 degrees C) water with inlet at 80 degrees F (27 degrees C) and room temperature of 90 degrees F (32 degrees C), when tested in accordance with ASHRAE Std 18.
 - 2. Electrical: 115 V, 60 Hertz compressor, 6 foot (2 m) cord and plug for connection to electric wiring system including grounding connector.
- C. Bottle Filler: Materials to match fountain.

2.9 MOP SINKS

- A. Mop Sink Manufacturers:
 - 1. Acorn Engineering Company: www.acorneng.com.
 - 2. Fiat Products: www.fiat.ca.
 - 3. Zurn Industries, Inc.: www.zurn.com.
 - 4. Substitutions: See Division 1.
- B. Material: Terrazo with stainless steel curb cap on all sides.
- C. Type: Rectilinear.
- D. Dimensions: As indicated on drawings.
- E. Accessories:
 - 1. 5 feet (1.5 m) of 1/2 inch (13 mm) diameter plain end reinforced plastic hose with vacuum breaker.
 - 2. Hose clamp hanger.
 - 3. Mop hanger.
- F. Preparation: install on wet mortar bed to prevent cracking.

2.10 EMERGENCY EYE AND FACE WASH

- A. Emergency Wash Manufacturers:
 - 1. Bradley: www.bradleycorp.com.
 - 2. Haws Corporation: www.hawesco.com.
 - 3. Substitutions: See Division 1.
- B. Emergency Wash: ANSI Z358.1; counter top, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, countertop sink eye and face wash receptor, twin eye wash heads on swiveling countertop mounted arm, dust covers, copper alloy control valve and fittings.

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

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.

3.4 CLEANING

- A. Clean plumbing fixtures and equipment.

3.5 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 23 05 17
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2016.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

1.4 SUBMITTALS

- A. See Division 1, 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 Division 1, for additional provisions.
 - 2. Extra Valve Stem Packings: Two for each type and size of valve.

1.5 QUALITY ASSURANCE

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

1.6 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.

1.7 WARRANTY

- A. See Section See Division 1, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PIPE SLEEVES

- A. Manufacturers:
 - 1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com.

- B. 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.
- C. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- D. Pipe Passing Through Below Grade Exterior Walls:
 1. Zinc coated or cast iron pipe.
 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- E. 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.
- F. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 2. Connect sleeve with floor plate except in mechanical rooms.
- G. Penetrations in concrete beam flanges are permitted but are prohibited through ribs or beams without prior approval from the Architect.
- H. 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 07 84 00 to prevent the spread of fire, smoke, and gases.

2.2 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
 1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com.
 2. Flexicraft Industries; PipeSeal: www.flexicraft.com.
 3. CALPICO, Inc..
 4. Metraflex Company (The).
- B. 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 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 (15 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 07 84 00 to prevent the spread of fire, smoke, and gases.

3. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

G. Manufactured Sleeve-Seal Systems:

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

H. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.2 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 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 23 05 48 - Vibration and Seismic Controls for HVAC.

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 2016a.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping 2014 (Reapproved 2020).
- 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 (2018).
- F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.
- G. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position 2018.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- J. MFMA-4 - Metal Framing Standards Publication 2004.
- K. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).
- L. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. 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 03 30 00.

1.5 SUBMITTALS

- A. See Division 1, 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.
1. Fiberglass Channel (Strut) Framing Systems: Include requirements for strength derating according to ambient temperature.
- 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.

1.6 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- D. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 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. Include consideration for vibration, equipment operation, and shock loads where applicable.
 4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.

- a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - e. Folco, a division of Eaton Corporation: www.eaton.com.
 - f. Substitutions: See Section 01 66 00 - Product Delivery, Storage and Handling See Division 1.
 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 gage, 0.1046 inch (2.66 mm).
 6. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
- C. Fiberglass Channel (Strut) Framing Systems: Factory-fabricated continuous-slot fiberglass channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports. (For use in the Greenhouses only)
1. Channel Material: Use polyester resin or vinyl ester resin.
 2. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 1 inch (25 mm) height.
 3. Flammability: Fire retardant with NFPA 101, Class A flame spread index (maximum of 25) when tested in accordance with ASTM E84; self-extinguishing in accordance with ASTM D635.
- 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.
- E. Steel Cable:
1. Manufacturers:
 - a. Ductmate Industries, Inc, a DMI Company; Clutcher Cable Hanging System : www.ductmate.com.
 - b. Substitutions: See Division 1.
 - c. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
- F. Thermal Insulated Pipe Supports:

1. Manufacturers:
 - a. Buckaroos, Inc: www.buckaroos.com.
 - b. KB Enterprises: www.snappitz.com.
 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.
 - b. Substitutions: See Division 1.
- G. Pipe Supports:
1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - e. Folco, a division of Eaton Corporation: www.eaton.com.
 - f. Substitutions: See Division 1.
 - g. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 2. 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.
 3. Operating Temperatures from 122 to 446 degrees F (50 to 230 degrees C):
 - a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.
- H. 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.
 - b. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - c. Ferguson Enterprises Inc: www.fnw.com.

- d. Thomas & Betts Corporation: www.tnb.com.
 - e. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - f. Folco, a division of Eaton Corporation: www.eaton.com.
 - g. Substitutions: See Division 1.
 - h. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- I. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - e. Folco, a division of Eaton Corporation: www.eaton.com.
 - f. Substitutions: See Division 1.
 - g. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 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.
- J. Riser Clamps:
1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - e. Folco, a division of Eaton Corporation: www.eaton.com.
 - f. Substitutions: See Division 1.
 - g. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 2. Provide copper plated clamps for copper tubing support.
 3. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- K. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - e. Folco, a division of Eaton Corporation: www.eaton.com.
 - f. Substitutions: See Division 1.
 - g. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- L. Strut Clamps: Two-piece pipe clamp.
1. Manufacturers:

- a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - e. Folco, a division of Eaton Corporation: www.eaton.com.
 - f. Substitutions: See Division 1.
 - g. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- M. Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- 1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - e. Folco, a division of Eaton Corporation: www.eaton.com.
 - f. Substitutions: See Division 1.
 - g. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- N. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
- 1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Ferguson Enterprises Inc: www.fnw.com.
 - c. Thomas & Betts Corporation: www.tnb.com.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
 - e. Folco, a division of Eaton Corporation: www.eaton.com.
 - f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 3. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- O. Nonmetallic Pipe Hangers:
- 1. Manufacturers:
 - a. DecoShield Systems, Inc; Snap-2 Hangers: www.decoshield.com.
 - b. Substitutions: See Division 1.
- P. Intermediate Pipe Guides: Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
- 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com.
 - b. Substitutions: See Division 1.
 - c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Pipe Diameter 6 inches (150 mm) and Smaller: Provide minimum clearance of 0.16 inch (4 mm).
- Q. Pipe Alignment Guides: Galvanized steel.
- 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com.
 - b. Substitutions: See Division 1.

- c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 2. Pipe Diameter 8 inches (200 mm) and Smaller: Spider or sleeve type.
 3. Pipe Diameter 10 inches (250 mm) and Larger: Roller type.
- R. 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.
- S. Pipe Shields for Insulated Piping:
 1. Manufacturers:
 - a. Anvil International: www.anvilintl.com.
 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.
- T. Anchors and Fasteners:
 1. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com.
 - b. Substitutions: See Division 1.
 2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.us.hilti.com.
 - b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com.
 - c. Powers Fasteners, Inc: www.powers.com.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com.
 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. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
- U. Pipe Installation Accessories:
 1. Copper Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - 2) Substitutions: See Division 1.

- 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.
2. Thermal Insulated Pipe Supports:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - 2) Substitutions: See Division 1.
 - 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.
3. Inserts and Clamps:
 - a. Manufacturers:
 - 1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - 2) Substitutions: See Division 1.
 - 3) Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by a single manufacturer.

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. Identify and coordinate all grade beam penetrations with the Structural Engineer
- 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 03 30 00.
 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 01 45 00 - Quality Control, 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 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Seismic control requirements.
 - 1. Includes requirements for seismic qualification of equipment not specified in this section.
- C. Vibration isolators.
- D. External seismic snubber assemblies.
- E. Seismic restraint systems.
- F. Vibration-isolated and/or seismically engineered roof curbs.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.3 DEFINITIONS

- A. HVAC Component: Where referenced in this section in regards to seismic controls, applies to any portion of the HVAC system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., ductwork, piping).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.4 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASCE 19 - Structural Applications of Steel Cables for Buildings 2016.
- C. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications Most Recent Edition Cited by Referring Code or Reference Standard.
- D. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment 2014.
- E. FEMA 413 - Installing Seismic Restraints for Electrical Equipment 2004.
- F. FEMA 414 - Installing Seismic Restraints for Duct and Pipe 2004.
- G. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage 2012.
- H. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components 2010, with Editorial Revision (2015).
- I. MFMA-4 - Metal Framing Standards Publication 2004.
- J. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment 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. Seismic Controls:
 - a. Coordinate the arrangement of seismic restraints with piping, conduit, equipment, and other potential conflicts installed under other sections or by others.
 - b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
 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 03 30 00.

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
 2. Seismic Controls: Include seismic load capacities.
- D. Shop Drawings - Vibration Isolation Systems:
 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.
- E. Shop Drawings - Seismic Controls:
 1. Include dimensioned plan views and sections indicating proposed HVAC component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.
 2. Identify mounting conditions required for equipment seismic qualification.
 3. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 4. Indicate proposed arrangement of distributed system trapeze support groupings.
 5. Indicate proposed locations for distributed system flexible fittings and/or connections.
 6. Indicate locations of seismic separations where applicable.
 7. Include point load drawings indicating design loads transmitted to structure at each attachment location.
- F. Seismic Design Data:
 1. Compile information on project-specific characteristics of actual installed HVAC components necessary for determining seismic design forces required to design appropriate seismic controls, including but not limited to the following.
 - a. Component operating weight and center of gravity.
 - b. Component elevation in the building in relation to the roof elevation (z/h).
 - c. Component importance factor (I_p).
 - d. For distributed systems, component materials and connection methods.

- e. Component amplification factor (a_p) and component response modification factor (R_p), determined in accordance with ASCE 7 tables.
- f. Applicability of overstrength factor (for certain anchorage in concrete and masonry).
- 2. Include structural calculations, stamped or sealed by seismic controls designer, demonstrating suitability of seismic controls for seismic design forces.
- G. Evaluation Reports: For products specified as requiring evaluation and recognition by a qualified evaluation service, provide current evaluation reports.
- H. 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.
- I. Manufacturer's detailed field testing and inspection procedures.
- J. Field quality control test reports.

1.7 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Seismic Controls Designer Qualifications: Registered professional engineer licensed in the State in which the Project is located and with minimum five years experience designing seismic restraints for nonstructural components.
 - 1. Designer may be employed by the manufacturer of the seismic restraint products.

1.8 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 VIBRATION ISOLATION REQUIREMENTS

- A. Provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 - 4. Select vibration isolators for outdoor equipment to comply with wind design requirements.
 - 5. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2-inch (50 mm) operating clearance beneath base unless otherwise indicated.

2.2 SEISMIC CONTROL REQUIREMENTS

- A. Design and provide HVAC component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor HVAC components.

- B. Seismic Design Criteria: Obtain from project Structural Engineer of Record.
- C. Component Importance Factor (I_p): HVAC components essential to life safety to be assigned a component importance factor (I_p) of 1.5 as indicated or as required. This includes but is not limited to:
 - 1. HVAC components required to function for life safety purposes after an earthquake.
 - 2. HVAC components that support or otherwise contain hazardous substances.
- D. Seismic Qualification of Equipment:
 - 1. Provide special certification for HVAC equipment furnished under other sections and assigned a component importance factor (I_p) of 1.5, certifying that equipment will remain operable following a design level earthquake.
 - 2. Seismic qualification to be by shake table testing in accordance with recognized testing standard procedure, such as ICC-ES AC156, acceptable to authorities having jurisdiction.
 - 3. Notify Architect and obtain direction where mounting restrictions required by conditions of seismic certification conflict with specified requirements.
 - 4. Seismically qualified equipment to be furnished with factory-installed labels referencing certificate of compliance and associated mounting restrictions.
- E. Premanufactured Modular HVAC Equipment: Where not otherwise seismically qualified, premanufactured modules 6 feet (1.8 m) high and taller furnished under other sections to be designed in accordance with seismic provisions for nonbuilding structures.
- F. Seismic Restraints:
 - 1. Provide seismic restraints for HVAC components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
 - 2. Seismic Restraint Exemptions:
 - a. Exemptions for Seismic Design Category C:
 - 1) HVAC components where either of the following apply:
 - a) The component importance factor (I_p) is 1.0 and the component is positively attached to the structure.
 - b) The component weighs 20 pounds (89 N) or less or, in the case of a distributed system, 5 pounds per foot (73 N/m) or less.
 - 2) HVAC piping with component importance factor (I_p) of 1.5 and nominal pipe size of 2 inch (50 mm) or less, where flexible connections, expansion loops, or other assemblies are provided between piping and associated components, and where piping is positively attached to the structure; exemption does not apply to piping constructed of low-deformability materials (e.g., cast iron, glass, nonductile plastics).
 - b. Exemptions for Seismic Design Category D, E, and F:
 - 1) Discrete HVAC components that are positively attached to the structure where either of the following apply:
 - a) The component weighs 400 pounds (1,780 N) or less, has a center of mass located 4 feet (1.22 m) or less above the adjacent floor level, flexible connections are provided between the component and associated ductwork, piping, and conduit, and the component importance factor (I_p) is 1.0.
 - b) The component weighs 20 pounds (89 N) or less or, in the case of a distributed system, 5 pounds per foot (73 N/m) or less.
 - 2) HVAC piping with component importance factor (I_p) of 1.0 and nominal pipe size of 3 inch (80 mm) or less, or with component importance factor (I_p) of 1.5 and nominal pipe size of 1 inch (25 mm) or less, where flexible connections,

expansion loops, or other assemblies are provided between piping and associated components, and where piping is positively attached to the structure; exemption does not apply to piping constructed of low-deformability materials (e.g., cast iron, glass, nonductile plastics).

- c. Duct System Exemptions, All Seismic Design Categories:
 - 1) Duct systems not designed to carry toxic, highly toxic, or flammable gases and not used for smoke control with component importance factor (I_p) of 1.0, where flexible connections or other assemblies are provided between duct system and associated components, where duct system is positively attached to the structure, and where one of the following apply:
 - a) Trapeze supported duct with trapeze assemblies using 3/8 inch (10 mm) diameter rod hangers not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 100 pounds (445 N) or less.
 - b) Trapeze supported duct with trapeze assemblies using 1/2 inch (13 mm) diameter rod hangers not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 200 pounds (890 N) or less.
 - c) Trapeze supported duct with trapeze assemblies using 1/2 inch (13 mm) diameter rod hangers not exceeding 24 inches (610 mm) in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 100 pounds (445 N) or less.
 - d) Hanger supported duct with individual rod hangers 3/8 inch (10 mm) or 1/2 inch (13 mm) in diameter not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, and the total weight supported by any single rod is 50 pounds (220 N) or less.
 - 2) Duct systems not designed to carry toxic, highly toxic, or flammable gases and not used for smoke control, where there are provisions to avoid impact with other ducts or mechanical components or to protect ducts in the event of such impact, and where duct system is positively attached to the structure and has a cross sectional area of less than 6 square feet (0.557 sq m) and weighs 20 pounds per foot (292 N/m) or less.
- d. HVAC Piping Exemptions, All Seismic Design Categories:
 - 1) HVAC piping where flexible connections, expansion loops, or other assemblies are provided between piping and associated components, where piping is positively attached to the structure, and where one of the following apply:
 - a) Trapeze supported piping weighing less than 10 pounds per foot (146 N/m), where all pipes supported meet size requirements for exemption as single pipes described under specific seismic design category exemptions above.
 - b) Trapeze supported piping with trapeze assemblies using 3/8 inch (10 mm) diameter rod hangers not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, where all pipes supported have a component importance factor (I_p) of 1.0 and meet size requirements for exemption as single pipes described under specific seismic design category exemptions above, and where the total weight supported by any single trapeze is 100 pounds (445 N) or less.
 - c) Trapeze supported piping with trapeze assemblies using 1/2 inch (13 mm) diameter rod hangers not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, where all pipes supported have a component importance factor (I_p) of 1.0 and meet size

requirements for exemption as single pipes described under specific seismic design category exemptions above, and where the total weight supported by any single trapeze is 200 pounds (890 N) or less.

- d) Trapeze supported piping with trapeze assemblies using 1/2 inch (13 mm) diameter rod hangers not exceeding 24 inches (610 mm) in length from support point connection to the supporting structure, where all pipes supported have a component importance factor (I_p) of 1.0 and meet size requirements for exemption as single pipes described under specific seismic design category exemptions above, and where the total weight supported by any single trapeze is 100 pounds (445 N) or less.
 - e) Hanger supported piping with individual rod hangers 3/8 inch (10 mm) or 1/2 inch (13 mm) in diameter not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, where pipe has a component importance factor (I_p) of 1.0 and meets size requirements for exemption as single pipes described under specific seismic design category exemptions above, and where the total weight supported by any single rod is 50 pounds (220 N) or less.
3. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:
 - a. ASHRAE (HVACA).
 - b. FEMA 412.
 - c. FEMA 413.
 - d. FEMA 414.
 - e. FEMA E-74.
 - f. SMACNA (SRM).
 4. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
 5. Seismic Type Vibration Isolators:
 - a. Comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 6. External Seismic Snubber Assemblies:
 - a. Provide quantity and arrangement of external seismic snubber assemblies as required to restrain equipment in all directions (both lateral and vertical).
 - b. Do not use external seismic snubber assemblies that restrain equipment only in one or more lateral directions (but not vertical) except where uplift forces are zero or are addressed by other restraints.
 7. Seismic Restraint Systems:
 - a. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
 - b. Use only cable restraints to restrain vibration-isolated HVAC components, including distributed systems.
 - c. Use only one restraint system type for a given HVAC component or distributed system (e.g., ductwork, piping) run; mixing of cable and rigid restraints on a given component/run is not permitted.
 - d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain HVAC component in all lateral directions; consider bracket geometry in anchor load calculations.
 - e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid

- restraints loaded in tension, in excess of downward tensile load due to supported HVAC component weight.
- f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported HVAC component weight.
 - g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
 - h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
 - i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.
8. Ductwork Applications:
- a. Provide independent support and seismic restraint for in-line components (e.g., fans, heat exchangers, humidifiers) having an operating weight greater than 75 pounds (334 N).
 - b. Positively attach appurtenances (e.g., dampers, louvers, diffusers) with mechanical fasteners.
- G. Seismic Attachments:
1. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.
 2. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.
 3. Do not use power-actuated fasteners.
 4. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.
 5. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 6. Concrete Housekeeping Pads:
 - a. Increase size of pad as required to comply with anchor requirements.
 - b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.
- H. Seismic Interactions:
1. Include provisions to prevent seismic impact between HVAC components and other structural or nonstructural components.
 2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.
- I. Seismic Relative Displacement Provisions:
1. Use suitable fittings or flexible connections to accommodate:
 - a. Relative displacements at connections between components, including distributed systems (e.g., ductwork, piping); do not exceed load limits for equipment utility connections.
 - b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
 - c. Design displacements at seismic separations.

- d. Anticipated drifts between floors.

2.3 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

A. Manufacturers:

- 1. Vibration-Isolated Equipment Support Bases:
 - a. Kinetics Noise Control, Inc: www.kineticsnoise.com.
 - b. Mason Industries: www.mason-ind.com.
 - c. Substitutions: See Div 1.

B. Vibration-Isolated Structural Steel Bases:

- 1. Description: Engineered structural steel frames with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.

C. Vibration-Isolated Concrete Inertia Bases:

- 1. Description: Concrete-filled engineered steel forms with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.
- 2. Minimum Base Depth: 6 inches (152 mm).
- 3. Minimum Base Mass (Including Concrete): 1.5 times weight of supported equipment.
- 4. Concrete Reinforcement: Welded or tied reinforcing bars running both ways in a single layer.
- 5. Concrete: Filled on site with minimum 3000 psi (20 mPa) concrete in accordance with Section 03 30 00.

2.4 VIBRATION ISOLATORS

A. Manufacturers:

- 1. Vibration Isolators:
 - a. Kinetics Noise Control, Inc: www.kineticsnoise.com.
 - b. Mason Industries: www.mason-ind.com.
 - c. Vibration Eliminator Company, Inc: www.veco-nyc.com.
 - d. Substitutions: See Division 1.

B. General Requirements:

- 1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
- 2. Spring Elements for Spring Isolators:
 - a. Color code or otherwise identify springs to indicate load capacity.
 - b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
 - c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
 - d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
 - e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
 - f. Selected to function without undue stress or overloading.
- 3. Seismic Snubbing Elements for Seismic Isolators:
 - a. Air Gap: Between 0.125 inches (3 mm) and 0.25 inches (6 mm) unless otherwise indicated.
 - b. Points of Contact: Cushioned with resilient material, minimum 0.25 inch (6 mm) thick; capable of being visually inspected for damage and replaced.

C. Vibration Isolators for Nonseismic Applications:

- 1. Resilient Material Isolator Pads:

- a. Description: Single or multiple layer pads utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material.
- b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch (6 mm) thickness.
- c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.
2. Resilient Material Isolator Mounts, Nonseismic:
 - a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material; fail-safe type.
3. Housed Spring Isolators:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.
 - b. Furnished with integral elastomeric snubbing elements, nonadjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.
 - c. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - d. Furnished with integral leveling device for positioning and securing supported equipment.
4. Restrained Spring Isolators, Nonseismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop.
 - b. Bottom Load Plate: Steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.
 - d. Provides constant free and operating height.
5. Resilient Material Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the lower hanger rod connection.
6. Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
7. Combination Resilient Material/Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the upper hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
8. Thrust Restraints:

- a. Description: Assembly utilizing free-standing, laterally stable steel spring designed for resisting horizontal motion due to thrust (e.g., air pressure from a fan), and intended for installation in pairs.
- D. Vibration Isolators for Seismic Applications:
1. Resilient Material Isolator Mounts, Seismic:
 - a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) isolator material; specifically designed and rated for seismic applications with integral snubbing in all directions.
 2. Restrained Spring Isolators, Seismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) in series with elastomeric (e.g., neoprene, rubber) isolator material within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop; specifically designed and rated for seismic applications with integral snubbing in all directions.
 - b. Bottom Load Plate: Steel with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.
 - d. Provides constant free and operating height.
 3. Resilient Material Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) isolator material for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
 4. Spring Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
 5. Combination Resilient Material/Spring Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) isolator material for the upper hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.

2.5 ACOUSTICAL AND VIBRATION ISOLATORS

- A. Manufacturers:
1. Acoustical and Vibration Isolators:
 - a. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - b. Mason Industries.
 - c. Kinetics Noise Control, Inc: www.kineticsnoise.com.
 - d. Substitutions: See Division 1.

B. General Requirements:

1. Acoustical Isolation System: Through-stud isolators, pipe clamps, riser clamp pads, neoprene and felt lining material and associated support brackets.

2.6 EXTERNAL SEISMIC SNUBBER ASSEMBLIES

A. Manufacturers:

1. External Seismic Snubber Assemblies:
 - a. Kinetics Noise Control, Inc: www.kineticsnoise.com.
 - b. Mason Industries: www.mason-ind.com.
 - c. Vibration Eliminator Company, Inc: www.veco-nyc.com.

- B. Description: Steel snubbing assemblies designed for external attachment to both equipment and supporting structure that, as part of a complete system, restrain equipment motion in all directions during a seismic event while maintaining vibration isolation during normal operation.

C. Seismic Snubbing Elements:

1. Air Gap: Between 0.125 inches (3 mm) and 0.25 inches (6 mm) unless otherwise indicated.
2. Points of Contact: Cushioned with resilient material, minimum 0.25 inch (6 mm) thick; capable of being visually inspected for damage and replaced.

2.7 SEISMIC RESTRAINT SYSTEMS

A. Manufacturers:

1. Seismic Restraint Systems:
 - a. AFCON, a brand of Anvil International: www.anvilintl.com.
 - b. Eaton Corporation: www.eaton.com.
 - c. Kinetics Noise Control, Inc: www.kineticsnoise.com.
 - d. Mason Industries: www.mason-ind.com.

- B. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.

C. Cable Restraints:

1. Comply with ASCE 19.
2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
4. Use protective thimbles for cable loops where potential for cable damage exists.

- D. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

2.8 VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS

A. Manufacturers:

1. Vibration-Isolated and/or Seismically Engineered Roof Curbs:
 - a. Kinetics Noise Control, Inc; [_____]: www.kineticsnoise.com.
 - b. Mason Industries; [_____]: www.mason-ind.com.
 - c. Vibration Eliminator Company, Inc; [_____]: www.veco-nyc.com.
 - d. Substitutions: See Division 1.

B. Vibration Isolation Curbs:

1. Nonseismic Curb Rail:
 - a. Location: Between existing roof curb and rooftop equipment.
 - b. Construction: Aluminum.

- c. Integral vibration isolation to comply with requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
- 2. Nonseismic Curb:
 - a. Location: Between structure and rooftop equipment.
 - b. Construction: Aluminum.
 - c. Integral vibration isolation to comply with requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
- 3. Seismic Curb:
 - a. Location: Between structure and rooftop equipment.
 - b. Construction: Steel.
 - c. Integral vibration isolation to comply with requirements of this section.
 - d. Snubbers consist of minimum 0.25 inch (6 mm) thick resilient pads to avoid metal-to-metal contact without compromising vibration isolating capabilities.
 - e. Weather exposed components consist of corrosion resistant materials.
- C. Seismic Type Nonisolated Curb and Fabricated Equipment Piers:
 - 1. Location: Between structure and rooftop equipment.
 - 2. Construction: Steel.
 - 3. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Architect in accordance with Section 01 45 33 and statement of special inspections as required by applicable building code.
- B. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.
 - 1. Continuous Special Inspections: Special Inspection Agency to be present in the area where the work is being performed and observe the work at all times the work is in progress.
 - 2. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.
- C. Seismic special inspections include, but are not limited to:
 - 1. Seismically Qualified Equipment: Verification that label, anchorage, and mounting comply with the certificate of compliance.
 - 2. Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units for Seismic Design Categories C, D, E, and F; periodic inspection.
 - 3. Installation and anchorage of ductwork designed to carry hazardous materials for Seismic Design Categories C, D, E and F; periodic inspection.
 - 4. Installation and anchorage of vibration isolation systems for Seismic Design Categories C, D, E, and F where the approved Contract Documents require a nominal clearance of 1/4

- inch (6.4 mm) or less between equipment support frame and seismic restraint; periodic inspection.
5. Verification of required clearances between HVAC equipment, distribution systems, and associated supports and fire protection sprinkler system drops and sprigs for Seismic Design Categories C, D, E, and F; periodic inspection.
 - D. Prior to starting work, Contractor to submit written statement of responsibility to authorities having jurisdiction and to Owner acknowledging awareness of special requirements contained in the statement of special inspections.
 - E. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.3 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. Secure fasteners according to manufacturer's recommended torque settings.
- D. Field-Welding (where approved by Architect): Comply with Section 05 50 00.
- E. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- F. Vibration Isolation Systems:
 1. Vibration-Isolated Equipment Support Bases:
 - a. Provide specified minimum clearance beneath base.
 2. Spring Isolators:
 - a. Position equipment at operating height; provide temporary blocking as required.
 - b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
 - c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
 3. Isolator Hangers:
 - a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
 - b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.
 4. Thrust Restraints:
 - a. Adjust restraint movement under normal operating static pressure.
 5. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 6. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 7. Adjust isolators to be free of isolation short circuits during normal operation.
 8. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.
- G. Seismic Controls:
 1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris, or other obstructions.
 2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.

3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch (3 mm), use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch (3 mm) or less.
4. Equipment with Sheet Metal Housings:
 - a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.
 - b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.
 - c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.
5. Concrete Housekeeping Pads:
 - a. Size in accordance with seismic design to meet anchor requirements.
 - b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.
6. Seismic Restraint Systems:
 - a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
 - b. Install restraints within permissible angles in accordance with seismic design.
 - c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.
 - d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
 - e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.4 FIELD QUALITY CONTROL

- A. See Section See Division 1, for additional requirements.
- B. Inspect vibration isolation and/or seismic control components for damage and defects.
- C. Provide manufacturer representative or authorized technician services to assist with inspection and testing of vibration isolation systems and seismic controls. Submit a detailed copy of manufacturer recommended inspection, testing, and field report procedures.
- D. Vibration Isolation Systems:
 1. Verify isolator static deflections.
 2. Verify required clearance beneath vibration-isolated equipment support bases.
 3. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- E. Seismic Controls:
 1. Verify snubbing element air gaps.
- F. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.
- G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.5 ATTACHMENTS

- A. Statement of special inspections.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 09 90 00 - Painting: Identification painting.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- C. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Automatic Controls: Tags. Key to control schematic.
- C. Control Panels: Nameplates.
- D. Ductwork: Nameplates.
- E. Heat Transfer Equipment: Nameplates.
- F. Piping: Tags.
- G. Small-sized Equipment: Tags.
- H. Thermostats: Nameplates.
- I. Water Meters: Nameplates.

2.2 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com.
 - 2. Brimar Industries, Inc: www.pipemarker.com.
 - 3. Craftmark Pipe Markers: www.craftmarkid.com.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
 - 5. Seton Identification Products, a Tricor Direct Company: www.seton.com.
 - 6. Substitutions: See Division 1..
- B. Letter Color: White.
- C. Letter Height: 1/4 inch (6 mm).
- D. Background Color: Black.

2.3 TAGS

- A. Manufacturers:

1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
2. Brady Corporation: www.bradycorp.com.
3. Brimar Industries, Inc: www.pipemarkers.com.
4. Craftmark Pipe Markers: www.craftmarkid.com.
5. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
6. Seton Identification Products, a Tricor Company: www.seton.com.
7. Substitutions: See Section 01 66 00 - Product Delivery, Storage and Handling See Division 1.

2.4 ADHESIVE-BACKED DUCT MARKERS

- A. Manufacturers:
 1. Brimar Industries, Inc: www.pipemarkers.com.
 2. Craftmark Pipe Markers: www.craftmarkid.com.
 3. Substitutions: See Division 1.
- 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: Yellow/Black.

2.5 STENCILS

- A. Manufacturers:
 1. Brady Corporation: www.bradycorp.com.
 2. Craftmark Pipe Markers: www.craftmarkid.com.
 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
 4. Seton Identification Products, a Tricor Company: www.seton.com.
 5. Substitutions: See Division 1.
- B. Stencils: With clean cut symbols and letters of following size:
 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.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 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 09 90 00.
- 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.
 1. Identify service, flow direction, and pressure.

2. Install in clear view and align with axis of piping.
- H. Install ductwork with plastic nameplates. 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.
- I. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

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SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Measurement of final operating condition of HVAC systems.
- C. Sound measurement of equipment operating conditions.
- D. Commissioning activities.

1.2 RELATED REQUIREMENTS

- A. Section 01 91 00 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

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. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing 2002.

1.4 SUBMITTALS

- A. See Section 01 30 00 - 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. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 4. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.
 - e. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - f. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.

- g. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - h. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - i. Method of checking building static and exhaust fan and/or relief damper capacity.
 - j. Proposed selection points for sound measurements and sound measurement methods.
 - k. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - l. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Progress Reports.
- F. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- 1. Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
 - 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 3. 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.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
 - 7. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project altitude.
 - j. Report date.

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. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 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. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- C. 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. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- 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. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. 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.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

3.7 COMMISSIONING

- A. See Sections See Division 1 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 a random sample equivalent to 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.

3.8 SCOPE

- A. Test, adjust, and balance the following:
 1. Air Source Heat Pumps.
 2. Air Handling Units & Fancoils.
 3. Exhaust or Supply Fans.
 4. Air Filters.
 5. Air Inlets and Outlets.

3.9 MINIMUM DATA TO BE REPORTED

- A. Air Cooled Condensers:
 - 1. Identification/number.
 - 2. Location.
 - 3. Manufacturer.
 - 4. Model number.
 - 5. Serial number.
 - 6. Entering DB air temperature, design and actual.
 - 7. Leaving DB air temperature, design and actual.
- B. 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. Fan RPM.
- C. Return Air/Outside Air:
 - 1. Identification/location.
 - 2. Design air flow.
 - 3. Actual air flow.
- D. 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.
- E. Duct Traverses:
 - 1. System zone/branch.
 - 2. Duct size.
 - 3. Area.
 - 4. Design velocity.
 - 5. Design air flow.
 - 6. Test velocity.
 - 7. Test air flow.
 - 8. Duct static pressure.
 - 9. Air temperature.
- F. Sound Level Reports:
 - 1. Location.
 - 2. Octave bands - equipment off.
 - 3. Octave bands - equipment on.

END OF SECTION

SECTION 23 07 13 DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 84 00 - Firestopping.
- C. Section 09 90 00 - Painting: Painting insulation jackets.
- D. Section 23 05 53 - Identification for HVAC Piping and Equipment.

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 C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- E. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation 2020.
- F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material) 2019.
- G. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings 2019.
- H. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers 2015.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1, 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.
 - 2. Johns Manville: www.jm.com.
 - 3. JP Lamborn Co; Thermal Sleeve MT: www.jpflex.com.
 - 4. Knauf Insulation; Atmosphere Duct Wrap: www.knaufinsulation.com.
 - 5. Owens Corning Corporation: www.ocbuildingspec.com.
- 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. Manufacturers:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90..
 - b. Vimasco Corporation; 749.
- E. Indoor Vapor Barrier Mastic:
 - 1. Manufacturers:
 - a. Design Polymeric; DP 3040 Water Based, Zero VOC, Premium Quality, Low Perm, Vapor Barrier Coating: www.designpoly.com.

2.3 JACKETS

- A. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square (2.45 kg/sq m).
- 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.
 - 6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.
- C. Flexible Weather-Proofing Outdoor Jacket: Self-healing, field-applied outdoor cladding.
 - 1. Material: Aluminum foil/polymer laminate with rubberized asphalt layer and acrylic adhesive.
 - 2. Thickness: 34 mils (0.86 mm).
 - 3. Finish: Embossed.
 - 4. Color: Silver.
 - 5. Water Vapor Transmission: 0.002 perm inch (0.0029 ng/Pa s m), maximum, when tested in accordance with ASTM E96/E96M.
 - 6. Mold Resistance: Pass when tested in accordance with ASTM C1338.
 - 7. Emissivity: 0.30 when tested in accordance with ASTM C1371.
 - 8. Manufacturers:
 - a. Polyguard Products; Alumaguard: www.polyguardproducts.com.com.

2.4 DUCT LINER

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com.
 - 2. Ductmate Industries, Inc, a DMI Company: www.ductmate.com.
 - 3. Johns Manville: www.jm.com.
 - 4. Knauf Insulation: www.knaufinsulation.com.
 - 5. Owens Corning Corporation: www.ocbuildingspec.com.
- B. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
 - 1. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F (0.045 at 24 degrees C).
 - 2. Service Temperature: Up to 250 degrees F (121 degrees C).
 - 3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm (25.4 m/s), minimum.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916.
 - 1. Manufacturers:
 - a. Design Polymerics; DP 2502 Water Based, Low VOC, Duct Liner Adhesive : www.designpoly.com.
- 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 or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- E. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with aluminum sheet metal insulation shield. Indoor unconditioned spaces or covered areas that are subject to outside temperatures are considered exterior applications (crawlspaces, etc.).
- F. Slope exterior ductwork to shed water.
- G. 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. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. 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.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- H. 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. Evaporative Condenser Intake and Exhaust:
- B. Exhaust Ducts Within 10 ft (3 m) of Exterior Openings:
- C. Exhaust Ducts Exposed to Outdoor Air:
- D. Outside Air Intake Ducts:
- E. Plenums:
- F. Plenums (Cooling System):
- G. Ventilation Equipment Casings:
- H. Supply Ducts:

- I. Supply Ducts From Fans to Vertical Ducts in Shafts (Cooling System):
- J. Supply Ducts in Vertical Shafts (Cooling Systems):
- K. Supply ducts After Terminal Boxes:
- L. Return and Relief Ducts in Mechanical Rooms:
- M. Ducts Exposed to Outdoors:

END OF SECTION

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SECTION 23 07 19 HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 23 81 29 - Variable Refrigerant Flow HVAC Systems

1.3 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus 2019.
- B. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).
- C. ASTM D610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces 2008 (Reapproved 2019).
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- E. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- F. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1, 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.

1.6 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 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - 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.

2.3 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

- A. Manufacturers:
 - 1. Airex Manufacturing, Inc: www.airexmfg.com/.
 - 2. Substitutions: See Division 1.
- B. Basis of Design: Airex Manufacturing, Inc; www.airexmfg.com.
 - 1. Pipe Penetration Wall Seal: Airex Titan Outlet.
 - 2. Refrigeration Pipe Insulation Protection System: Airex E-Flex Guard.
 - 3. Pipe Penetration Wall Seal and Insulation Protection System: Airex Pro-System Kit.
- C. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
 - 1. Outlet Cover Color: Gray.
- D. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
 - 1. PVC Insulation Cover Color: Black with full-length velcro fastener.
 - 2. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

2.4 ACCESSORIES

- A. General Requirements:
 - 1. Provide required accessories in accordance with and subject to the recommendations of the insulation manufacturer.
 - 2. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
 - 3. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
 - 4. Supply materials that are asbestos free.
- B. Corrosion Inhibitors:
 - 1. Corrosion Control Gel:
 - a. Corrosion Protection: Comply with ASTM B117 and ASTM D610.

PART 3 EXECUTION

3.1 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. 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.
- G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with canvas jacket sized for finish painting.

3.3 SCHEDULE

- A. Cooling Systems:
 - 1. Cold Condensate Drains:
 - 2. Condensate Drains from Cooling Coils:
 - 3. Refrigerant Suction:
 - 4. Refrigerant Hot Gas:

END OF SECTION

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SECTION 23 09 23 DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- B. Section 23 09 93 - Sequence of Operations for HVAC Controls.
- C. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.2 REFERENCE STANDARDS

- A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata and Amendments (2022).

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Delta Controls: www.deltacontrols.com/#sle.
- B. Honeywell International, Inc: www.honeywell.com/#sle.
- C. Johnson Controls, Inc: www.johnsoncontrols.com/#sle.
- D. Schneider Electric: www.schneider-electric.us/#sle.
- E. Siemens AG, Building Technologies Division: www.siemens.com/#sle.
- F. Reliable Controls: reliablecontrols.com.
- G. Substitutions: See Division 1.

2.2 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.3 OPERATOR INTERFACE

- A. PC Based Work Station using internet connection (WAN) to access site based controller on site LAN using standard HTML browser. All functions and features shall be accessible remotely by multiple owner's representatives under multiple preprogramed user login accounts with customized security access levels of access to controller information and features.
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.

C. BACnet protocol to comply with ASHRAE Std 135.

2.4 CONTROLLERS

A. Building Controllers:

1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F (4 to 65 degrees C).
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet (1 m).
- B. Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.

- b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.5 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

- F. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.6 SYSTEM SOFTWARE

A. Operating System:

- 1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - b. Acceptable Operating Systems: Windows 10/11 workstation using MS Edge, Chrome or Firefox browsers.
- 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - a) Analog and binary values.
 - b) Dynamic text.
 - c) Static text.
 - d) Animation files.
- 3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
- 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Fan Coil Units.
 - 2) Condensers.
 - 3) Energy Recovery Ventilation Unit
 - b. Ancillary Equipment:
 - 1) Exhaust Fans.

B. Workstation System Applications:

- 1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
- 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
- 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
- 4. On-line Help:

- a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
5. Security:
- a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.
6. System Diagnostics:
- a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
 - b. Device failure is annunciated to the operator.
7. Alarm Processing:
- a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
8. Alarm Messages:
- a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
- a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
10. Custom Trend Logs:
- a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:

- 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
 12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
 13. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).
 14. Reports:
 - a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - a) Alarm History.
 - b) System messages.
 - c) System events.
 - d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.

- c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - a) Monthly showing daily natural gas consumption for each meter.
 - b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
 - a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- C. Workstation Applications Editors:
- 1. Provide editing software for each system application at PC workstation.
 - 2. Downloaded application is executed at controller panel.
 - 3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
 - 4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
 - 5. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.

- 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
- 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.7 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 1. User access secured via user passwords and user names.
 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
 1. Binary object is set to alarm based on the operator specified state.
 2. Analog object to have high/low alarm limits.
 3. All alarming is capable of being automatically and manually disabled.
 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.
- H. PID Control Characteristics:
 1. Direct or reverse action.
 2. Anti-windup.
 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 4. User selectable controlled variable, set-point, and PED gains.
- I. Staggered Start Application:
 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 2. Order of equipment startup is user selectable.
- J. Energy Calculations:
 1. Accumulated instantaneous power or flow rates are converted to energy use data.

2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- K. Anti-Short Cycling:
1. All binary output objects protected from short-cycling.
 2. Allows minimum on-time and off-time to be selected.
- L. On-Off Control with Differential:
1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- M. Run-Time Totalization:
1. Totalize run-times for all binary input objects.
 2. Provides operator with capability to assign high run-time alarm.

2.8 HVAC CONTROL PROGRAMS

- A. General:
1. Support Inch-pounds and SI (metric) units of measurement.
 2. Identify each HVAC Control system.
- B. Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 3. Operator commands:
 - a. Define term schedule.
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.
 - e. Define heating/cooling parameters.
 4. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Occupancy and vacancy times.
 - h. Optimal run time system heating/cooling mode parameters.
 5. HVAC point summary:
 - a. Control system identifier and status.
 - b. Point ID and status.
 - c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and point.
 - e. Calculated optimal start and stop times.
 - f. Period start.
- C. Supply Air Reset:

1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.
- C. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 2 day period.
- C. Provide basic operator training for 6 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 16 hours dedicated instructor time. Provide training on site.

3.4 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.

3.5 MAINTENANCE

- A. See Section Division 1 for additional requirements relating to maintenance service.
- B. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
- C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- D. Provide complete service of systems, including call backs. Make minimum of 6 complete normal inspections of approximately 40 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Sequence of operation for:
 - 1. Air Source Heat Pumps
 - 2. Telecom Rooms
 - 3. Electrical rooms.
 - 4. Exhaust Fans
 - 5. Fan coil units.
 - 6. Water Flow Meters

1.2 RELATED REQUIREMENTS

- A. Division 1: Commissioning requirements that apply to all types of work.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
 - 1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
 - 2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in Contract Documents.
 - 3. Include at least the following sequences:
 - a. Start-up.
 - b. Warm-up & pull-down modes.
 - c. Normal operating mode.
 - d. Unoccupied mode.
 - e. Shutdown.
 - f. Capacity control sequences and equipment staging.
 - g. Temperature and pressure control, such as setbacks, setups, resets, etc.
 - h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - i. Sequences for all alarms and emergency shut downs.
 - j. Seasonal operational differences and recommendations.
 - k. Interactions and interlocks with other systems.
 - 4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 - 5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.

6. Include schedules, if known.
- C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
1. Label with settings, adjustable range of control and limits.
 2. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 3. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 4. Include all monitoring, control and virtual points specified in elsewhere.
 5. Include a key to all abbreviations.
- D. Points List: Submit list of all control points indicating at least the following for each point.
1. Name of controlled system.
 2. Point abbreviation.
 3. Point description; such as dry bulb temperature, airflow, etc.
 4. Display unit.
 5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
 6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
 7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
 8. Calculated point (Yes / No); i.e. a “virtual” soft point generated from calculations of other point values.
- E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.4 QUALITY ASSURANCE

- A. Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the State in which the Project is located.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 AIR SOURCE HEAT PUMPS

- A. Architecture Approach: Most VRV/VRF systems, including the BOD manufacturer Daikin, are designed to operate most efficiently with their own proprietary local controllers, and offering central control for many of the key variables while maintaining algorithms optimized for condenser and fancoil control within their local controllers. This ASHP section is written starting with the assumption that the manufacturer's local controller & thermostats are used, relying on those predefined algorithms to give the specific speed and capacity commands for the condensers and fancoils. We, therefore, focus primarily on the central controls sequences & variables/points in the following paragraphs. Because the integration of a VRV/VRF manufacturer's local controls and a third party's DDC controls system will be unique for each project, we encourage the winning bidder to propose any specific improvements in the owner's experience or overall value from the way the two systems are integrated. A general use allocation of points has been indicated in the points list and is intended to be used to pick up owner requests for integrating additional points/variables identified after project award by the owner and/or the Engineer Of Record (EOR).

- B. Run Conditions - Scheduled: The unit shall run according to a user-definable time schedule in the following modes:
- C. Occupied Mode: The unit shall maintain temperatures listed in HVAC design criteria document, which vary by space.
- D. Unoccupied Mode (night setback): The unit shall maintain
 1. A 85°F (adj.) cooling setpoint.
 2. A 55°F (adj.) heating setpoint.
- E. Alarms shall be provided as follows:
 1. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user-definable amount (adj.).
 2. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user-definable amount (adj.).
- F. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
- G. Zone Optimal Start: The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of the scheduled occupied period.
- H. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
- I. Smoke Detection: The unit shall shut down and generate an alarm upon receiving a smoke detector status (where available).
- J. Fan: The fan shall run anytime the unit is commanded to run, unless shutdown on safeties. The fan speeds shall be run at the lowest speeds deemed necessary to maintain the space setpoints using the algorithms preconfigured within the manufacturer's fancoil controller. When economizer cooling is enabled, the fan shall ramp up as needed to maximize economizer cooling opportunities before enabling direct cooling.
- K. Installer shall coordinate and confirm with owner's rep which zones shall run:
 1. 24/7 or as scheduled (program schedules as needed).
 2. Intermittent or continuous fan operation during occupied hours (may vary by zone).
 3. Constant fan speed or allow fancoil to automatically vary speed to suit varying loads (recommended).
- L. Heating and Cooling - Compressor: The condensers compressors shall be cycled on/off by the manufacturer's compressor controller to maintain zone temperature and where variable speed, shall vary the compressors speed to maintain space setpoint in collaboration with the variable fan speed fancoils. The compressor shall run subject to its own internal safeties and controls.
- M. The heating mode shall be enabled whenever:
 1. Outside air temperature is less than 65°F (adj.).
 2. AND the fan status is on.
- N. AND the reversing valve is in heat mode.
- O. The cooling shall be enabled whenever:
 1. Outside air temperature is greater than 60°F (adj.).
 2. AND the fan status is on.
 3. AND the reversing valve is in cool mode.

- P. On mode change, the compressor shall be disabled and remain off until after the reversing valve has changed position.
- Q. Economizer (where indicated on plans and/or required by codes): The controller shall measure the zone temperature and modulate the mixed air dampers in sequence to maintain the zone cooling setpoint. The outside air damper shall maintain a minimum air adjustable position (adj.) open whenever occupied. The minimum air damper position shall be determined by coordinating measured airflows in the field by the TAB provider. Refer to the project T-24 compliance forms and the equipment schedules, for the required minimum outside air flows for each unit. Use the larger of the two if the two sources differ. The economizer shall be enabled whenever:
 - 1. Outside air temperature is at least 3°F (adj.) less than the zone temperature.
 - 2. AND the outside air temperature is less than 75°F (adj.)
- R. The economizer shall close whenever the unit is in the unoccupied mode, except where cooling is requested and the economizer is enabled based on temperatures to maintain the night setback temperature.
- S. The outside air damper shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.
- T. Minimum Outside Air Ventilation - Carbon Dioxide (CO2) Control (where indicated on plans and/or required by codes):
When in the occupied mode, the controller shall measure the zone CO2 concentration and open the outside air dampers on rising CO2 concentrations, overriding normal damper operation as CO2 concentrations rise above 750ppm (adj.).
- U. Shut Off and Temperature Setup/Setback (where indicated on plans and/or required by codes):
 - 1. When the occupancy sensors indicate that all of the spaces on a zone has been unpopulated for 5 minutes continuously during the occupied mode, the zone shall be set in "occupied standby mode". During the occupied standby mode, the active heating set point shall be decreased by 2°F and the cooling set point shall be increased by 2°F.
 - 2. During occupied standby mode, all airflow to the zone shall be shut off whenever the space is between the active heating and cooling setpoints, as adjusted above.
 - a. Shut off the fancoil serving this zone.
 - b. Shut off the OA damper.
- V. Fan Status: The controller shall monitor the fan status.
- W. Fan Status: The controller shall monitor the fan status.
- X. Alarms shall be provided as follows:
 - 1. Fan Failure: Commanded on, but the status is off.
 - 2. Fan in Hand: Commanded off, but the status is on.
 - 3. Fan Runtime Exceeded: Fan status runtime exceeds a user-definable limit (adj.).
- Y. Zone Carbon Dioxide (CO2) Concentration Monitoring:
The controller shall measure the zone CO2 concentration.
- Z. Alarms shall be provided as follows:
- AA. High Zone Carbon Dioxide Concentration: If the zone CO2 concentration is greater than 1000ppm (adj.) when in the occupied mode.

3.2 TELECOM ROOMS

- A. Run Conditions - 24/7: The unit shall run 24 hours a day, 365 days a year.

- B. Adjust wall-mounted stand-alone thermostat to maintain a room temperature setpoint of 65-80 degrees F.
- C. Provide wall-mounted temperature sensor for remote monitoring of room temperatures.
- D. On room temperatures above 90 degrees F (32 degrees C), signal alarm.

3.3 ELECTRICAL ROOMS

- A. Run Conditions - 24/7: The unit shall run 24 hours a day, 365 days a year.
- B. Adjust line-voltage thermostat to run fan at room temperatures above 85 degrees F.

3.4 ENERGY RECOVERY UNITS

- A. Run Conditions - Interlock to run whenever restroom fancoils are running.
- B. Fans: The fans shall run at constant speed.
- C. Fan Status: The controller shall monitor the fan status.
- D. Alarms shall be provided as follows:
 - 1. Fan Failure: Commanded on, but the status is off.
 - 2. Fan in Hand: Commanded off, but the status is on.
 - 3. Fan Runtime Exceeded: Fan status runtime exceeds a user-definable limit (adj.).

3.5 EXHAUST FANS

- A. Run Conditions - where indicated as "Scheduled" in exhaust fans equipment schedule notes: The fan shall run according to a user-definable schedule. Refer to schedule for all control methods on the project for exhaust fans.
- B. Fan: The fan shall have a user-definable (adj.) minimum runtime.
- C. Fan Status: The controller shall monitor the fan status.
- D. Alarms shall be provided as follows:
 - 1. Fan Failure: Commanded on, but the status is off.
 - 2. Fan in Hand: Commanded off, but the status is on.
 - 3. Fan Runtime Exceeded: Fan status runtime exceeds a user-definable limit (adj.).

3.6 FAN COIL UNITS

- A. Refer to notes in "VRV Zonal Units" equipment schedule and "Thermostat Type and Placement" matrix on sheet M6.01 for control requirements for each fancoil and zone.
- B. Refer to HVAC Design Criteria document for owner requested setpoints and operational details.
- C. In zones where two fancoils serve a single zone, both fancoils shall be operated in parallel and not stages when unloading to serve light loads to prevent uneven space temperatures and nuisance drafts (ex. Fitness, Library),.
- D. In the North and South community halls, each side is configured to operate as separate zones for when the dividing wall is extended and physically separates the two rooms. Provide wall override buttons with instructional signage to "override" the zones to operate as two distinct zones, where the normal or "default" operation is to have these zones run interlocked to run as a single zone. In this default mode, the thermostats shall run in a Leader/follower arrangement, which the Leader side chosen by owner's rep
- E. In spaces that have two zones within a larger open space (ex. Z-1A & 1B or Z-13 & 14), the owner has requested the smaller "sub-zone" to address a specific concern about uneven space temperatures. The DBE shall provide a means of control interlock that optimizes space comfort and energy efficiency, in particular minimizing or eliminating simultaneous heating & cooling

from the two zones. This may be a "most demanding" strategy or other as approved by the owner's rep.

3.7 WATER FLOW METERS

- A. Water Meter: The controller shall monitor the water meter for water consumption on a continual basis. These values shall be made available to the system at all times.
- B. Alarm shall be generated as follows:
 - 1. Invalid Reading: Sensor reading indicates an invalid value from the water meter (beyond the rated GPM for example).
- C. Peak Demand History: The controller shall monitor and record the peak (high and low) demand readings from the water meter. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.
- D. Usage History: The controller shall monitor and record water meter readings so as to provide a water consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

END OF SECTION

SECTION 23 31 00 HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 09 91 23 - Interior Painting: Weld priming, paint or coating.
- B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
- C. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
- D. Section 23 33 00 - Air Duct Accessories.
- E. Section 23 37 00 - 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 2020.
- D. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems 2020.
- E. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements 2015.
- F. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements 2015.
- G. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements 2015.
- H. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements 2016.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- J. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- L. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines 2001.
- M. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual 2012.
- N. UL 1978 - Grease Ducts Current Edition, Including All Revisions.
- O. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed specified requirements.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).
- E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

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, and approved by manufacturer.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.6 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 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): 1 inch w.g. (250 Pa) pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 1 inch w.g. (250 Pa) pressure class, galvanized steel.
- E. Return and Relief: 1 inch w.g. (250 Pa) pressure class, galvanized steel.
- F. General Exhaust: 1 inch w.g. (250 Pa) pressure class, galvanized steel.
- G. Outside Air Intake: 1/2 inch wg (125 Pa) pressure class, galvanized steel.
- H. Transfer Air and Sound Boots: 1 inch w.g. (250 Pa) pressure class, galvanized steel with 1" acoustical lining.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- C. 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. Manufacturers:
 - a. Powers Fasteners, Inc: www.powers.com.

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. Duct systems have been designed for metal duct. At the Contractor's option, fibrous glass duct may be substituted for metal duct.
- D. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- E. 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.
- F. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- G. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- H. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- I. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

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. Double Wall Insulated Flat Oval Ducts: Machine made from round spiral lockseam duct.
 1. Manufacture in accordance with SMACNA (DCS).
 2. Fittings: Manufacture with solid inner wall.
 3. Inner Wall: Perforated galvanized steel.
- C. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
 1. Manufacture in accordance with SMACNA (DCS).
- D. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 1. Manufacture in accordance with SMACNA (DCS).
- E. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 1. Manufacture in accordance with SMACNA (DCS).
 2. Manufacturers:
 - a. EHG, a DMI Company: www.ehgduct.com.
 - b. Linx Industries, Inc, a DMI Company: www.li-hvac.com.
 - c. MKT Metal Manufacturing: www.mktduct.com.

- F. Phenolic Ducts: Rigid thermoset phenolic resin, with 1 mil (25.4 micron) aluminum foil dual-facing. Reinforced with a 0.2 inch (5 mm) glass scrim.
 - 1. Panel Wall Thickness: Minimum 0.875 inch (22 mm).
 - 2. Finish: UV resistant glass reinforced polyester/epoxy (GRP/GRE) cladding system.
 - 3. Manufacturers:
 - a. Kingspan Insulation LLC; The Kingspan KoolDuct System: www.kingspaninsulation.us.
 - b. Substitutions: See Div 1.
- G. Flexible Ducts: Black or grey polymer film supported by helically wound spring steel wire.
 - 1. UL labeled.
 - 2. Insulation: Fiberglass insulation with aluminized vapor barrier film.
 - 3. Pressure Rating: 4 inches wg (1000 Pa) positive and 0.5 inches wg (175 Pa) negative.
 - 4. Maximum Velocity: 4000 fpm (20.3 m/sec).
 - 5. Temperature Range: Minus 20 degrees F to 175 degrees F (Minus 28 degrees C to 79 degrees C).
 - 6. Manufacturers:
 - a. Hart & Cooley, Inc: www.hartandcooley.com.
 - b. Thermaflex MK-E: www.thermaflex.net.
 - c. Substitutions: See Division 1.
- H. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc, a DMI Company: www.ductmate.com.
 - b. Substitutions: See Division 1.
- I. Kitchen Hood and Grease Exhaust Ducts:
 - 1. Fabricate in accordance with ductwork manufacturer's instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.
 - 2. Single-Wall, Premanufactured Kitchen Exhaust Duct:
 - a. UL labeled to UL 1978.
 - b. Construct of 18 gauge, 0.0500 inch (1.27 mm) stainless steel using continuous external welded joints in rectangular sections.
 - 3. Double-Wall, Premanufactured, Noncombustible Kitchen Exhaust Ducts:
 - a. Comply with ASTM E2336.
 - b. Construct of 18 gauge, 0.0500 inch (1.27 mm) stainless steel using continuous external welded joints in rectangular sections.
 - c. Manufacturers:
 - 1) DuraSystems Barriers Inc; DuraDuct KEX: www.durasystems.com.
 - 2) Captiveaire.
 - 3) Silkirk Corporation.
 - 4) Substitutions: See Division 1.
- J. Kitchen Hood and Grease Exhaust Ducts with Integral Insulation: Nominal 3 inches (76.2 mm) thick ceramic fiber insulation between 20 gage, 0.0375 inch (0.95 mm), Type 304 stainless steel liner and 24 gage, 0.0239 inch (0.61 mm) aluminized steel sheet outer jacket.
 - 1. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
 - 2. Certified for zero clearance to combustible material in accordance with:
 - a. UL 2221 with a 2 hour rating.

3. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:
 - a. UL 1978.
 - b. UL 2221.
 4. Manufacturers:
 - a. AMPCO by Hart & Cooley, Inc; Z-Clear: www.ampcostacks.com.
 - b. DuraVent; DuraZDuct (DIS3Z): www.duravent.com.
 - c. Security Chimneys International; Secure Duct (CIX3Z): www.securitychimneys.com.
 - d. Selkirk Corporation; ZeroClear (IPS-Z3): www.selkirkcommercial.com.
 - e. Captiveaire.
 - f. Substitutions: See Division 1.
- K. Dishwasher Exhaust Ducts: Minimum 21 gage, 0.0344 inch (0.87 mm) thick, single wall, Type 304 stainless steel.
1. Single wall, factory built chimney liner system.
 2. Designed, fabricated, and installed to be liquidtight preventing exhaust leakage into the building.
 3. Joints to be sealed during installation with factory supplied overlapping V-bands and sealant.
 4. Manufacturers:
 - a. AMPCO by Hart & Cooley, Inc; Model N: www.ampcostacks.com.
 - b. Selkirk Corporation; Model G: www.selkirkcommercial.com.
 - c. Captiveaire
 - d. Substitutions: See Division 1.

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.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge, 0.0598 inch (1.52 mm) sheet steel back facing and 22 gauge, 0.0299 inch (0.76 mm) perforated sheet steel front facing with 3/32 inch (2.4 mm) diameter holes on 5/32 inch (4 mm) centers. Construct panels 3 inches (75 mm) thick packed with 4.5 lb/cu ft (72 kg/cu m) minimum glass fiber insulation media, on inverted channels of 16 gauge, 0.0598 inch (1.52 mm) sheet steel.

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. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- F. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- G. 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.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. 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.
- J. Use double nuts and lock washers on threaded rod supports.
- K. 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.
- L. 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.
- M. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.
- N. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

3.2 CLEANING

- A. See Division 1 for additional requirements.
- B. all ducts should be sealed and protected during the entire construction process, until the HVAC systems are ready to be turned on following the guidelines and mandatory requirements in T-24 Part 11, CalGreen code.

END OF SECTION

SECTION 23 33 00 AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Combination fire and smoke dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Fire dampers.
- G. Flexible duct connectors.
- H. Volume control dampers.
- I. Low leakage (Class 1A) control dampers.

1.2 RELATED REQUIREMENTS

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- B. Section 23 31 00 - HVAC Ducts and Casings.
- C. Section 23 90 00 - Energy Management and Control System

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- B. NFPA 92 - Standard for Smoke Control Systems 2021.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- 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 Division 1, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- C. Project Record Drawings: Record actual locations of access doors and test holes.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1, for additional provisions.

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. Ruskin Company: www.ruskin.com.
 - 2. Titus HVAC, a brand of Johnson Controls: www.titus-hvac.com.
 - 3. Price Industries..
 - 4. Substitutions: See Division 1.
- B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.2 BACKDRAFT DAMPERS - METAL

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com.
 - 2. Nailor Industries, Inc: www.nailor.com.
 - 3. Ruskin Company: www.ruskin.com.
 - 4. United Enertech: www.unitedenertech.com.
 - 5. Substitutions: See Division 1.
- B. Gravity Backdraft Dampers, Size 18 by 18 inches (450 by 450 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

- A. Products furnished per Section 25 35 23.
- B. Manufacturers:
 - 1. AireTechnologies, Inc, a DMI Company: www.airetechnologies.com.
 - 2. Lloyd Industries, Inc.: www.firedamper.com.
 - 3. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com.
 - 4. Nailor Industries, Inc: www.nailor.com.
 - 5. NCA, a brand of Metal Industries Inc: www.ncamfg.com.
 - 6. Pottorff: www.pottorff.com.
 - 7. Ruskin Company: www.ruskin.com.
 - 8. United Enertech: www.unitedenertech.com.
- C. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- D. Provide factory sleeve and collar for each damper.
- E. Multiple Blade Dampers: Fabricate with 16 gage, 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.
- F. Operators: UL listed and labelled spring return pneumatic type suitable for operation on 0-20 psig (0-140 kPa) instrument air. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- G. 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.
- H. 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.

- I. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.
- J. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.
- K. Security Bars: Comply with NFPA 90A, UL 555, and UL 555S. Install per manufacturer's instructions.
 - 1. Manufacturers:
 - a. Ruskin Company: www.ruskin.com.

2.4 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Acudor Products Inc, a Division of Nelson Industrial Inc: www.acudor.com.
 - 2. Ductmate Industries, Inc, a DMI Company: www.ductmate.com.
 - 3. Elgen Manufacturing, Inc: www.elgenmfg.com.
 - 4. Nailor Industries, Inc: www.nailor.com.
 - 5. Ruskin Company: www.ruskin.com.
 - 6. SEMCO LLC: www.semcohvac.com.
 - 7. Ward Industries, a brand of Hart and Cooley, Inc: www.wardind.com.
 - 8. Substitutions: See Division 1.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch (25 mm) thick insulation with sheet metal cover.
 - 1. Less Than 12 inches (300 mm) Square: Secure with sash locks.
 - 2. Up to 18 inches (450 mm) Square: Provide two hinges and two sash locks.
 - 3. Up to 24 by 48 inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
 - 4. Larger Sizes: Provide an additional hinge.
- D. 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.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
 - 1. Manufacturers:
 - a. Carlisle HVAC Products; Dynair Test Port with Red Cap with O-Ring Seal : www.carlislehvac.com.
 - b. Substitutions: See Division 1.

2.6 FIRE DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com.
 - 2. Nailor Industries, Inc: www.nailor.com.
 - 3. Ruskin Company: www.ruskin.com.
 - 4. Ward Industries, a brand of Hart and Cooley, Inc: www.wardind.com.

5. Substitutions: See Division 1.

2.7 FLEXIBLE DUCT CONNECTORS

- A. Manufacturers:
 1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric : www.carlislehvac.com.
 2. Ductmate Industries, Inc, a DMI Company: www.ductmate.com.
 3. Elgen Manufacturing, Inc: www.elgenmfg.com.
 4. Substitutions: See Division 1.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Flexible Duct Connections: Fabric crimped into metal edging strip.
 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd (1.0 kg/sq m).
 2. Metal: 3 inches (75 mm) wide, 24 gage, 0.0239 inch (0.61 mm) thick galvanized steel.
- D. Leaded Vinyl Sheet: Minimum 0.55 inch (14 mm) thick, 0.87 lbs per sq ft (4.2 kg/sq m), 10 dB attenuation in 10 to 10,000 Hz range.
- E. Maximum Installed Length: 14 inch (356 mm).

2.8 VOLUME CONTROL DAMPERS

- A. Products furnished per Section 25 35 23.
- B. Manufacturers:
 1. AireTechnologies, Inc, a DMI Company: www.airetechnologies.com.
 2. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com.
 3. MKT Metal Manufacturing: www.mktduct.com.
 4. Nailor Industries, Inc: www.nailor.com.
 5. NCA, a brand of Metal Industries Inc: www.ncamfg.com.
 6. Ruskin Company: www.ruskin.com.
 7. United Enertech: www.unitedenertech.com.
- C. Fabricate in accordance with SMACNA (DCS) and as indicated.
- D. Single Blade Dampers:
 1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
 2. Blade: 24 gage, 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 gage, 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.
 1. Manufacturers:
 - a. Carlisle HVAC Products; Dynair End Bearing Leak Resistant Sets : www.carlislehvac.com.
 - b. Elgen Manufacturing Company, Inc; Snap-in Bushing: www.elgenmfg.com.
- G. Quadrants:
 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

3. Manufacturers:
 - a. Carlisle HVAC Products; Dynair Double Shear Rattle Free Quadrants 1/2 inch : www.carlislehvac.com.
 - b. Substitutions: See Division 1.

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 23 31 00 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 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.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- G. Demonstrate re-setting of fire dampers to Owner's representative.
- H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- J. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off and as far from the inlets/outlets as possible. Provide remote mechanical (Young's modulator) or electrical remote actuators (Greenheck RBDR/RBD) for dampers that are placed in inaccessible areas to allow balancing damper access after project completion. Air systems with a single diffuser, grille, or register to not require a balancing damper unless shown on plans.

END OF SECTION

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SECTION 23 34 00 CEILING PROPELLER FANS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Ceiling propeller fans.

1.2 RELATED REQUIREMENTS

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- B. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connection.

1.3 REFERENCE STANDARDS

- A. UL 507 - Electric Fans Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan power, CFM, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

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. Deliver fans to project site in manufacturer's original packaging.
- B. Store fans under cover and elevated above grade in a safe, dry location.

1.7 WARRANTY

- A. See Division 1, for additional warranty requirements.
- B. Provide two year manufacturer warranty for the fan motor.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 507.
- B. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.2 CEILING PROPELLER FANS

- A. Manufacturers:
 - 1. Hunter Fan International: www.hunterfan.com.
 - 2. Big Ass Fan Company: www.bigassfans.com.
 - 3. Substitutions: See Division 1.
- B. Performance Ratings: refer to plans, varies by location
- C. Number of Fan Blades: refer to plans, varies by location.
- D. Fan Diameter: refer to plans, varies by location.

- E. Mounting Options: Ceiling.
- F. Direct Drive Fan:
 - 1. Statically and dynamically balanced.
 - 2. Motors:
 - a. Open drip-proof (ODP).
 - b. Heavy duty ball bearing type.
 - c. Mount on vibration isolators or resilient cradle mounts, out-of-airstream.
 - d. Fully accessible for maintenance.
- G. Shafts and Bearings:
 - 1. Fan Shaft:
 - a. Ground and polished steel with anti-corrosive coating.
 - b. First critical speed at least 25 percent over maximum cataloged operating speed.
 - 2. Bearings:
 - a. Permanently sealed or pillow block type.
 - b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - c. 100 percent factory tested.
- H. Accessories:
 - 1. Refer to drawings & other specification sections for any additional accessories not specified within this section.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure fan with cadmium plated steel lag screws to structure in compliance with ceiling fan mounting detail(s).
- C. Buildings equipped with ESFR sprinklers of any sprinklers, must comply with NFPA 13 and NFPA 72 guidelines.
- D. Ceiling-mounted Fans:
 - 1. Install fans with blades at elevations AFF indicated on plans. Provide custom rod lengths where needed to achieve this.

END OF SECTION

SECTION 23 34 23 HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof exhausters.
- B. Cabinet exhaust fans.
- C. Inline centrifugal fans.
- D. Kitchen hood upblast roof exhausters.

1.2 RELATED REQUIREMENTS

- A. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.
- C. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

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 2014.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- I. UL 705 - Power Ventilators Current Edition, Including All Revisions.
- J. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances Current Edition, Including All Revisions.

1.4 SUBMITTALS

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

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 FIELD CONDITIONS

- A. Permanent ventilators may not be used for ventilation during construction.
- B. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Carnes, a division of Carnes Company Inc: www.carnes.com.
- B. Greenheck Fan Corporation: www.greenheck.com.
- C. Loren Cook Company: www.lorencook.com.
- D. PennBarry, Division of Air System Components: www.pennbarry.com.
- E. Twin City Fan & Blower: www.tcf.com.
- F. Substitutions: See Division 1.

2.2 POWER VENTILATORS - GENERAL

- A. Manufacturers:
 - 1. Carnes, a division of Carnes Company Inc: www.carnes.com.
 - 2. Greenheck Fan Corporation: www.greenheck.com.
 - 3. PennBarry, Division of Air System Components: www.pennbarry.com.
 - 4. Loren Cook Fans: lorencook.com.
 - 5. Substitutions: See Division 1.
- B. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- C. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- D. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
- E. Fabrication: Comply with AMCA 99.
- F. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- G. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- H. Enclosed Safety Switches: Comply with NEMA 250.
- I. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

2.3 ROOF EXHAUSTERS

- A. 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.
- B. Roof Curb: 12 inch (300 mm) high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

- C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- D. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.4 CABINET EXHAUST FANS

- A. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
- B. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.
- C. Grille: Molded white plastic.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.5 INLINE CENTRIFUGAL FANS

- A. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
- B. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.
- C. Sheaves (where direct drive not indicated): Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.6 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

- A. Belt or direct Drive Fan:
 - 1. Fan Wheel:
 - a. Type: Non-overloading, backward inclined centrifugal.
 - b. Material: Aluminum.
 - 2. Statically and dynamically balanced.
 - 3. Motors:
 - a. Open drip-proof (ODP).
 - b. Heavy duty ball bearing type.
 - c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
 - d. Fully accessible for maintenance.
 - 4. Housing:
 - a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
 - b. Rigid internal support structure.
 - c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
 - d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
 - e. Provide breather tube for fresh air motor cooling and wiring.

- B. Shafts and Bearings:
 - 1. Fan Shaft:
 - a. Ground and polished steel with anti-corrosive coating.
 - b. First critical speed at least 25 percent over maximum cataloged operating speed.
 - 2. Bearings:
 - a. Permanently sealed or pillow block type.
 - b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - c. 100 percent factory tested.
- C. Drive Assembly:
 - 1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
 - 2. Belts: Static free and oil resistant.
 - 3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 - 4. Motor pulley adjustable for final system balancing.
 - 5. Readily accessible for maintenance.
- D. Disconnect Switches:
 - 1. Factory mounted and wired.
 - 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 3. Finish for Painted Steel Enclosures: Provide manufacturer's standard, factory applied gray, unless otherwise indicated.
 - 4. Positive electrical shutoff.
 - 5. Wired from fan motor to junction box installed within motor compartment.
- E. Roof Curb: self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, ventilated double wall, factory installed nailer strip.
- F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.
- G. Options/Accessories:
 - 1. Grease Trap:
 - a. Collects grease residue.
 - 2. Hinge Kit:
 - a. Hinges and restraint cables mounted to base (sleeve).
 - b. Allows fan to tilt away for access to wheel and ductwork for inspection and cleaning.

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. Hung Cabinet Fans:
 - 1. Install fans with resilient rubber or spring isolator mountings where indicated on mounting details and flexible electrical leads. Refer to Section 22 05 48.
 - 2. Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.
- E. Provide sheaves or speed controllers required for final air balance.

- F. Install backdraft dampers on the inlet to or from outside air.

END OF SECTION

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SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers:
 - 1. Architectural ceiling diffusers (TAG A).
 - 2. Round ceiling diffusers (TAG B)
- B. Registers/grilles:
 - 1. Ceiling-mounted, exhaust and return register/grilles (TAG E).
 - 2. Heavy duty bar return grilles (TAG G).
 - 3. Wall supply grilles (TAG D).
 - 4. Wall exhaust and return register/grilles (TAG E).
 - 5. Aeroblade supply grilles (TAG F)
 - 6. Wall-mounted, linear register/grilles (TAG C).
- C. Door grilles (TAG H).
- D. Louvers:
 - 1. Stationary wall louvers
 - 2. Combination louvers.
- E. Gravity ventilators.

1.2 REFERENCE STANDARDS

- A. AHRI 880 (I-P) - Performance Rating of Air Terminals 2017.
- B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating 2015.
- C. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices 2021.
- D. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers 2015, with Editorial Revision (2018).
- E. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets 2006 (Reaffirmed 2021).
- F. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units 2016.
- G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- H. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- J. UL 2518 - Standard for Safety Air Dispersion Systems Current Edition, Including All Revisions.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.
- L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- M. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.
- N. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.

O. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

1.3 SUBMITTALS

- A. See Division 1, for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Project Record Documents: Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.
- C. 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. Price Industries: www.price-hvac.com.
- B. Ruskin Company: www.ruskin.com.
- C. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com.
- D. Substitutions: See Division 1.

2.2 ROUND CEILING DIFFUSERS (TAG B)

- A. Type: Round, plaque, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sectorizing baffles where indicated. Diffuser collar shall project not more than 1 inch (25 mm) above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.
- B. Fabrication: Steel with baked enamel finish.
- C. Color: As selected by Architect from manufacturer's standard range.

2.3 ARCHITECTURAL CEILING DIFFUSERS (TAG A)

- A. Type: Square plaque in front of curved, recessed frame providing 360° airflow pattern.
- B. Frame: Titus frame type 1, surface mount, or equivalent surface mounted frame with concealed fasteners.
- C. Construction: Made of steel plaque and frame with factory enamel finish.
- D. Color: As selected by Architect from manufacturer's standard range.
- E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face (where indicated on plans).

2.4 CEILING EXHAUST AND RETURN REGISTERS/GRILLES (TAG E)

- A. Manufacturers:
 - 1. Krueger-HVAC: www.krueger-hvac.com.
- B. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with blades set at 45 degrees, vertical face.
- C. Frame: 1-1/4 inch (32 mm) margin with concealed mounting.

- D. Fabrication: Steel with 20 gage, 0.0359 inch (0.91 mm) minimum frames and 22 gage, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gage, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
- E. Color: To be selected by Architect from manufacturer's standard range.
- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.5 AEROBLADE SUPPLY GRILLES (TAG F)

- A. Type: Streamlined and individually adjustable blades, 2 inch (50.8 mm) minimum depth, 2 inch (50.8 mm) maximum spacing with spring or other device to set blades, vertical face, double deflection.
- B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille with two-way deflection.
- C. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.
- D. Fabrication: Steel with 20 gage, 0.0359 inch (0.91 mm) minimum frames and 22 gage, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gage, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
- E. Color: To be selected by Architect from manufacturer's standard range.
- F. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face (where indicated on plans).

2.6 WALL SUPPLY GRILLES (TAG D)

- A. Type: Streamlined and individually adjustable blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing with spring or other device to set blades, horizontal face, double deflection.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.
- C. Fabrication: Steel with 20 gage, 0.0359 inch (0.91 mm) minimum frames and 22 gage, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gage, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.
- E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face (where indicated on plans).

2.7 WALL EXHAUST AND RETURN REGISTERS/GRILLES (TAG E)

- A. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with spring or other device to set blades, horizontal face.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.
- C. Fabrication: Steel frames and blades, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.
- E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.8 HEAVY DUTY BAR RETURN GRILLES (TAG)

- A. Type: Fixed grilles of 1/2" spacing, 38° fixed deflection, blades parallel to long dimension.
- B. Fabrication: Heavy duty steel with factory baked enamel finish.
- C. Color: To be selected by Architect from manufacturer's standard range.

- D. Frame: 16 ga 1-1/4 inch (32 mm) margin with countersunk screw mounting.
- E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face (where indicated on plans).

2.9 LINEAR WALL REGISTERS/GRILLES TAG C)

- A. Type: Streamlined blades with 0 degree deflection, 1/8 by 3/4 inch (3.2 by 19 mm) on 1/2 inch (13 mm) centers.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.
- C. Fabrication: Aluminum extrusions, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.10 DOOR GRILLES (TAG H)

- A. Type: V-shaped louvers of 20 gage, 0.0359 inch (0.91 mm) thick steel, 1 inch (25 mm) deep on 1/2 inch (13 mm) centers.
- B. Frame: 20 gage, 0.0359 inch (0.91 mm) steel with auxiliary frame to give finished appearance on both sides of door, with factory prime coat finish.

2.11 STATIONARY WALL LOUVERS

- A. Type: 6 inch (150 mm) deep frame with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch (13 mm) square mesh screen or 1/8 in (3.1 mm) non corrosive mesh screen over; refer to drawing equipment schedule notes to determine which screen applies to each louver location.
- B. Fabrication: 12 gage, 0.1046 inch (2.66 mm) thick extruded aluminum thick galvanized steel welded assembly, with factory baked enamel finish.
- C. Color: To be selected by Architect from manufacturer's full range.
- D. Size: As indicated on the drawings.
- E. Mounting: Furnish with interior flat flange for installation.

2.12 GRAVITY VENTILATORS

- A. Hood Intake and Relief Gravity Ventilator:
 - 1. Manufacturers:
 - a. American Coolair Corporation: www.coolair.com.
 - b. Greenheck Fan Corporation: www.greenheck.com.
 - c. Loren Cook Company; [_____]: www.lorencook.com.
 - d. Substitutions: See Division 1.
 - 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. Birdscreen:
 - a. Fabricate in accordance with ASTM B221 (ASTM B221M).
 - b. Construction: 1/4 inch (6 mm) Galvanized mesh.
 - c. Horizontally mounted across hood intake area.
 - 4. Options/Accessories:

- a. Roof Curbs:
 - 1) Flat Roofs:
 - 2) Material: Galvanized.
 - 3) Insulation Thickness: 1 inch (25.4 mm).
 - b. Provide extended base minimum 7 inch (177.8 mm) extension to base height making overall base 12 inches (304.8 mm) in height to prevent snow or moisture intake.
 - c. Curb Seal: Rubber seal between fan and roof curb.
 - d. Dampers:
 - 1) Type: Counterbalanced Gravity.
 - 2) Factory designed to prevent outside air from entering back into building when fan is off.
 - 3) Balanced for minimal resistance to flow.
 - 4) Galvanized frames with pre-punched mounting holes.
- B. Spun Aluminum Intake and Relief Gravity Ventilator:
1. Manufacturers:
 - a. American Coolair Corporation: www.coolair.com.
 - b. Greenheck Fan Corporation: www.greenheck.com.
 - c. Loren Cook Company: www.lorencook.com.
 - d. Substitutions: See Division 1.
 2. General:
 - a. Provide low silhouette configuration for intake applications with natural gravity or negative pressure system.
 - 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:
 - a. Material: Aluminum.
 - b. Internal structure constructed of galvanized steel.
 4. Birdscreen:
 - a. Fabricate in accordance with ASTM B221 (ASTM B221M).
 - b. Construction: 1/2 inch (12.7 mm) galvanized mesh.
 - c. Horizontally mounted across hood intake area.
 5. Options/Accessories:
 - a. Dampers:
 - 1) Type: Gravity.
 - 2) Factory designed to prevent outside air from entering back into building when fan is off.
 - 3) Balanced for minimal resistance to flow.
 - 4) Galvanized frames with pre-punched mounting holes.
 - b. Factory Finish: Polyester meeting or exceeding the chemical resistance properties of air dry phenolic (heresite).
 - c. Flashing Flange:
 - d. Insect Screen:
 - 1) Fabricate in accordance with ASTM B221 (ASTM B221M).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black except where black acoustical lining is installed. Refer to Section 09 91 23.

3.2 AIR OUTLET AND INLET SCHEDULE

- A. Refer to mechanical equipment schedules (sheets M6.0X)

END OF SECTION

SECTION 23 63 13 AIR COOLED REFRIGERANT CONDENSERS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Equipment bases.
- B. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- C. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- D. Section 23 23 00 - Refrigerant Piping.
- E. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.
- C. ASHRAE Std 20 - Methods of Laboratory Testing Remote Mechanical-Draft Air-Cooled Refrigerant Condensers 2019.
- D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- F. NEMA MG 1 - Motors and Generators 2018.
- G. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical requirements, and wiring diagrams.
- C. Shop Drawings: Indicate components, assembly, dimensions, weights and loading, required clearances, and location and size of field connections. Include schematic layouts showing condenser, refrigeration compressors, cooling coils, refrigerant piping and accessories required for complete system.
- D. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- E. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

- F. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1, for additional provisions.
 - 2. Extra Fan Belts: 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.
- 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. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- B. Protect units on site from physical damage. Protect coils.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. DAIKIN, a part of Daikin North America LLC, a unit of Daikin Industries
: www.daikinac.com/content/
- B. Trane, a brand of Ingersoll Rand: www.trane.com.
- C. York International Corporation/Johnson Controls, Inc: www.york.com.
- D. Substitutions: See Division 1.

2.2 PERFORMANCE REQUIREMENTS

- A. Refer to equipment schedules on plans for rated capacities and other performance requirements.
- B. Electrical Characteristics:
 - 1. 208 volts, single phase, 60 Hz.
- C. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 05 83.

2.3 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 2016 T-24 Part 6 California Energy Conservation Code., in combination with compressor units.
- D. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.4 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.

2.5 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.

2.6 FANS AND MOTORS

- A. Side 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 23 05 13.

2.7 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 thermostat to cycle fan motors in response to outdoor ambient temperature.
- C. Refer to controls drawings for additional controls requirements including accessories, sensors and EMS tie-in.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide for connection to electrical service. Refer to Section 26 05 83.
- C. Install units on isolators where indicated on the associated mounting details on plans. Refer to Section 22 05 48.
- D. Provide connection to factory-sized refrigeration piping system. Refer to Section 23 23 00. Comply with ASHRAE Std 15.
- E. Provide cooling season start-up, winter season shut-down service, for first year of operation.
- F. 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

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SECTION 23 72 00
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Energy recovery ventilators.

1.2 RELATED REQUIREMENTS

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC.

1.3 REFERENCE STANDARDS

- A. AHRI 1060 (I-P) - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment 2018.
- B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Errata (2020).
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata and Amendments (2022).
- E. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings 2019.
- F. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).
- G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors current edition, including all revisions.

1.4 SUBMITTALS

- A. See Division 1 for submittal procedures.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

1.7 WARRANTY

- A. See Division 1 for additional warranty requirements.
- B. Manufacturer Warranty: Provide 1-year manufacturer warranty for equipment including parts, materials, workmanship, and operation commencing on date of Substantial Completion. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 ENERGY RECOVERY VENTILATOR

- A. Manufacturers:
 - 1. Greenheck: www.greenheck.com.
 - 2. RenewAire: www.renewaire.com.
 - 3. Daikin.
 - 4. Substitutions: See Section 01 66 00 - Product Delivery, Storage and Handling.
- B. ERV Equipment Construction Requirements:
 - 1. Energy Recovery Exchanger Type: Membrane plate.
 - 2. ERV Equipment Location: As indicated on drawings.
 - 3. Supply and Return Duct Connection Orientation: As indicated on drawings.
 - 4. Casing and Frame:
 - a. Frame: Galvanized steel body or welded extruded aluminum tubular frame capable of supporting components and casings including integral base lifting holes.
 - b. Double Wall Panels: Minimum of 18 gauge, 0.040 inch (1.02 mm) galvanized steel.
 - c. Doors: Construct doors of same construction and thickness as wall panels. Include p-shaped extruded neoprene gasket, prop rod, chain with spring, exterior handle, and interior 3-point latching device. Label each door to identify equipment located within.
 - d. Insulation Requirements:
 - 1) Mold Resistance: "Pass" when tested in accordance with ASTM C1338.
 - 2) Fungal Resistance: No growth when tested in accordance with ASTM G21.
 - 3) Bacteria Resistance: No growth when tested in accordance with UL 181.
 - 4) Flame spread index of 25 or less and maximum smoke developed index of 50.
 - e. Isolation and Sealing: Form continuous, thermally isolated, weathertight seal between inner wall of panels and structural framing with closed cell PVC foam gasketing and seal seams to prevent job site caulking.
 - f. Access Panels: Provide access to components through a large, tightly sealed and easily removable hinged or screwed access panel.
 - g. Finish: Polyurethane enamel over weather-protected, corrosion-resistant assembly.
 - h. Nameplate: Permanent name plate listing manufacturer, model number, serial number, voltage with tolerance, and amp ratings mounted inside door near electrical panel.
 - 5. Supply and Exhaust Fans:
 - a. Provide separate non-overloading, statically and dynamically balanced, draw-through, forward curved centrifugal fan or fan-array for each air stream.
 - b. Fan Motor: Constant Speed, high efficiency, load matched, belt-driven, open drip proof, thermal overload protected TEFC motor with variable-sheave belt drive, and adjustable-removable motor-slide base. Size drives to 150 percent of load, minimum.
 - c. Belt Guards: Full sized, hinged, painted with high-visibility safety color, and accessible with standard tools.
 - d. Motor Bearings: Permanently lubricated sealed ball bearings rated for not less than 200,000 hours of operation with accessible greased fittings.
 - 6. Filter Sections:
 - a. Outdoor-Intake and Exhaust Sides: 2 inch (50 mm) thick, pleated, MERV 13 filters, ASHRAE Std 52.2.
 - b. Filter Racks: Bolt-on rack constructed of aluminum with minimum size of 1/12 inch (2 mm) thick. Include hinged side access door and snap fasteners.

7. Vibration Isolation: Provide corrosion-resistant vibration isolation products for internal motors and other revolving parts. See Section 23 05 48.
8. Electrical:
 - a. 208 VAC, 1-phase with single-point power connection to nonfused main disconnect interlocked with control panel and other components.
 - b. Install internal wiring in accordance with NFPA 70 within flexible, liquid tight steel conduit.
9. Controls and Local Control Panel:
 - a. Unit Controls: Factory supplied DDC with sensors, limit switches, and frost control.
 - b. Provide fused disconnect within local control panel with power supplies, transformers, terminal strip or terminal blocks for interface of field installed components.
 - c. Service Status: Provide both local and remote indication of sensor readings and status of safeties and other status items including power on, wheel-rotation alarm, outside-air loaded filter and exhaust-air loaded filter.
 - d. Provide temperature, humidity, dewpoint temperature, CO₂, and wheel rotation sensors.
10. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
11. Configuration: Adjust listed requirements in conformance with ASHRAE Std 90.1 I-P.
12. Certification: AHRI 1060 (I-P) labeled, include copy of published ratings for operating conditions.

END OF SECTION

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SECTION 23 81 29
VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Variable refrigerant volume HVAC system includes:
 - 1. Outdoor/condensing unit(s).
 - 2. Indoor/evaporator units.
 - 3. Branch selector units.
 - 4. Refrigerant piping.
 - 5. Control panels.
 - 6. Control wiring.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 83 - Wiring Connections: Power connections to equipment.

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.
- B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- C. ITS (DIR) - Directory of Listed Products current edition.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1, for submittal procedures.
- B. Submittals: For proposed substitute systems/products, as defined in PART 2, and alternate systems/products, as defined above, proposer shall submit all data described in this article, under the terms given for substitutions stated in PART 2.
- C. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings indicated in Contract Documents:
 - 1. Outdoor/Central Units:
 - a. Refrigerant Type and Size of Charge.
 - b. Cooling Capacity: Btu/h (W).
 - c. Heating Capacity: Btu/h (W).
 - d. Cooling Input Power: Btu/h (kW).
 - e. Heating Input Power: Btu/h (kW).
 - f. Operating Temperature Range, Cooling and Heating.
 - g. Air Flow: Cubic feet per minute (Cubic meters per second).
 - h. Fan Curves.
 - i. External Static Pressure (ESP): Inches WG (Pa).
 - j. Sound Pressure Level: dB(A).
 - k. Electrical Data:
 - 1) Maximum Circuit Amps (MCA).
 - 2) Maximum Fuse Amps (MFA).

- 3) Maximum Starting Current (MSC).
- 4) Full Load Amps (FLA).
- 5) Total Over Current Amps (TOCA).
- 6) Fan Motor: HP (W).
- l. Weight and Dimensions.
- m. Maximum number of indoor units that can be served.
- n. Maximum refrigerant piping run from outdoor/condenser unit to indoor/evaporator unit.
- o. Maximum height difference between outdoor/condenser unit to indoor/evaporator unit, both above and below.
- p. Control Options.
2. Indoor/Evaporator Units:
 - a. Cooling Capacity: Btu/h (W).
 - b. Heating Capacity: Btu/h (W).
 - c. Cooling Input Power: Btu/h (kW).
 - d. Heating Input Power: Btu/h (kW).
 - e. Air Flow: Cubic feet per minute (Cubic meters per second).
 - f. Fan Curves.
 - g. External Static Pressure (ESP): Inches WG (Pa).
 - h. Sound Pressure level: dB(A).
 - i. Electrical Data:
 - 1) Maximum Circuit Amps (MCA).
 - 2) Maximum Fuse Amps (MFA).
 - 3) Maximum Starting Current (MSC).
 - 4) Full Load Amps (FLA).
 - 5) Total Over Current Amps (TOCA).
 - 6) Fan Motor: HP (W).
 - j. Maximum Lift of Built-in Condensate Pump.
 - k. Weight and Dimensions.
 - l. Control Options.
3. Control Panels: Complete description of options, control points, zones/groups.
- D. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:
 1. Detailed piping diagrams, with branch balancing devices.
 2. Condensate piping routing, size, and pump connections.
 3. Detailed power wiring diagrams.
 4. Detailed control wiring diagrams.
 5. Locations of required access through fixed construction.
 6. Drawings required by manufacturer.
- E. Design Data:
 1. Provide design calculations showing that system will achieve performance specified.
- F. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- G. Operating and Maintenance Data:

1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
 2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
 3. Identification of replaceable parts and local source of supply.
- H. Warranty: Executed warranty, made out in Owner's name.
- I. Specimen Warranty: Copy of manufacturer's warranties.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE AND HANDLING

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

1.7 WARRANTY

- A. Compressors: Provide manufacturer's warranty for six (6) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of Daikin AC (Americas), Inc. according to Daikin's terms and conditions. All warranty service work shall be performed by a Daikin factory trained service professional.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: The system design indicated in Contract Documents is based on equipment and system designed by Daikin AC; www.daikinac.com.
- B. Systems designed and manufactured by other manufacturers will be considered by Owner under the terms described for substitutions with the following exceptions:
1. Substitutions: See Division 1.
 2. Substitution requests will be considered only if required submittal data is complete; see article SUBMITTALS above.
 3. Contractor (not equipment supplier) shall certify that the use of the substitute system and equipment will not require changes to other work or re-design by the Engineers or the Architect.
 4. Contractor or HVAC subcontractor shall certify that the substitute system will achieve the performance specified.
 5. Do not assume substitution has been accepted until formal written notice has been issued by Architect.

2.2 HVAC SYSTEM DESIGN

- A. System Operation: Heating and cooling, simultaneously for CU-1 & CU-2, heating or cooling selected at the system level for CU-3.
1. Zoning: Provide capability for temperature control for each individual indoor/evaporator unit independently of all other units.
 2. Zoning: Provide heating/cooling selection for each individual indoor/evaporator unit independently of all other units.

- a. Exception: Where indicated, multiple indoor/evaporator units may be controlled in groups.
 - 3. Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.
 - 4. Conditioned spaces are indicated on drawings.
 - 5. Outdoor/Condenser unit locations are indicated on drawings.
 - 6. Indoor/Evaporator unit locations are indicated on drawings.
 - 7. Branch selector unit locations are indicated on drawings.
 - 8. Required equipment unit capacities are indicated on drawings.
 - 9. Refrigerant piping sizes are not indicated on drawings.
 - 10. Connect equipment to condensate piping provided by others; condensate piping is indicated on drawings.
- B. Refrigerant Piping Lengths: Provide equipment capable of serving system with the piping lengths shown on plans without any oil traps:
- 1. Minimum Piping Length from Outdoor/Central Unit(s) to Furthest Terminal Unit: 540 feet (165 m), actual; 620 feet (189 m), equivalent.
 - 2. Total Combined Liquid Line Length: 3280 feet (1000 m), minimum.
 - 3. Minimum Piping Length Between Indoor Units: 49 feet (15 mm).
- C. Control Wiring Lengths:
- 1. Between Outdoor/Condenser Unit and Indoor/Evaporator Unit: 6,665 feet (2031 m), minimum.
 - 2. Between Outdoor/Condenser Unit and Central Controller: 3,330 feet (1015 m), minimum.
 - 3. Between Indoor/Evaporator Unit and Remote Controller: 1,665 feet (507 m).
- D. Controls: Provide the following control interfaces:
- 1. For Each Indoor/Evaporator Unit: One wall-mounted wired "local" controller, with temperature sensor; locate where indicated. All units require a BACnet interface.
 - 2. One central remote control panel for entire system;
- E. Local Controllers: Wall-mounted, wired, containing temperature sensor.
- F. Remote Temperature Sensors: In addition to temperature sensors integral with indoor/evaporator units, provide wall-mounted, wired remote temperature sensors located in the zone served as indicated on plans or where requested by owner's rep the following:
- 1. Exception: Where a local controller with temperature sensor is provided for the particular unit and is located in the same space.

2.3 EQUIPMENT

- A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.
 - 1. Refrigerant: R-410A.
 - 2. Performance Certification: AHRI Certified; www.ahrinet.org.
 - 3. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL, listed in ITS (DIR), and bearing the certification label.
 - 4. Provide units capable of serving the zones indicated.
 - 5. Energy Efficiency: Report EER and COP based on tests conducted at "full load" in accordance with AHRI 210/240 or alternate test method approved by U.S. Department of Energy.
 - 6. Outdoor Units: Units and their supports designed and installed to resist wind pressures defined in ASCE 7.
- B. Electrical Characteristics:

1. Power - Condensing Units: 208 to 230 Volts, 3-phase, 60 Hz.
 2. Power - Indoor Units: 208 to 230 Volts, single phase, 60 Hz.
 3. 208-230 Voltage Range: 187 to 253 volts.
 4. Control: 16 volts DC.
- C. System Controls:
1. Include self diagnostic, auto-check functions to detect malfunctions and display the type and location.
- D. Remote Centralized Control Panel:
- E. Wiring:
1. Control Wiring: 18 AWG, 2-conductor, non-shielded, non-polarized, stranded cable.
 2. Control Wiring Configuration: Daisy chain.
- F. Refrigerant Piping:
1. Provide three-pipe refrigerant system, including high/low pressure dedicated hot gas, liquid and suction lines; two-pipe systems utilizing lower temperature mixed liquid/gas refrigerant to perform heat recovery are not permitted due to reduced heating capabilities.
 2. Refrigerant Flow Balancing: Provide refrigerant piping joints and headers specifically designed to ensure proper refrigerant balance and flow for optimum system capacity and performance; T-style joints are prohibited.
 3. Provide hard drawn copper above grade; soft drawn tubing may be used within underground conduits to facilitate pulling through conduit long sweep elbows.
 4. Insulate each refrigerant line individually between the condensing and indoor units.
 5. Underground piping routed insulated within non-metallic electrical conduit (see Div 26) with control wiring and both insulated pipes bundled periodically along their length.
 6. Minimum piping insulation thickness:
 - a. Vapor: 1.5" thick.
 - b. Liquid: 0.5" thick.

2.4 OUTDOOR/CONDENSING UNITS

- A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.
1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
 2. Refrigerant: Factory charged.
 3. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.
 4. Capable of being installed with wiring and piping to the left, right, rear or bottom.
 5. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle (cooling mode) oil return or defrost is not permitted, due to potential reduction in space temperature.
 6. Sound Pressure Level: As specified, measured at 3 feet (one meter) from front of unit; provide night setback sound control as a standard feature; three selectable sound level steps of 55 dB, 50 dB, and 45 dB, maximum.
 7. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.

8. Provide refrigerant auto-charging feature and refrigerant charge check function.
 9. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 10. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying to us indoor units.
 11. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
 12. Controls: Provide contacts for electrical demand shedding.
 13. Product:
 - a. Both "heat pump" and "heat recovery" products on prject; refer to sheet M6.01 for models and capacities.
- B. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.
1. Designed to allow side-by-side installation with minimum 4" spacing.
- C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (digitally commutating) inverter.
1. Provide minimum of 2 fans for each condensing unit.
 2. External Static Pressure: Factory set at 0.12 in WG (30 Pa), minimum.
 3. Indoor Mounted Air-Cooled Units: External static pressure field set at 0.32 in WG (80 Pa), minimum; provide for mounting of field-installed ducts.
 4. Fan Airflow: As indicated for specific equipment.
 5. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment.
- D. Condenser Coils: Copper tubes expanded into aluminum fins to form mechanical bond; waffle louver fin and rifled bore tube design to ensure high efficiency performance.
1. Copper Tube: Hi-X seamless copper tube.
 2. Coil Design: N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
 3. Corrosion Protection: Fins coated with anti-corrosion acrylic resin and hydrophilic film type E1; pipe plates coated with powdered polyester powder coating of 2.0 to 3.0 microns thickness.
- E. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.
1. Variable Speed Control: Capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure; high/low pressures calculated by samplings of evaporator and condenser temperatures every 20 seconds, with compressor capacity adjusted to eliminate deviation from target value by changing inverter frequency or on/off setting of fixed speed compressors.
 2. Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.
 3. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.

4. Inverter Driven Compressors: PVM inverter driven, highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G2-type” with maximum speed of 7,980 rpm.
5. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.
6. Provide oil separators and intelligent oil management system.
7. Provide spring mounted vibration isolators.

2.5 BRANCH SELECTOR UNITS

- A. Branch Selector Units: Concealed boxes designed specifically for this type of system to control heating/cooling mode selection of downstream units; consisting of electronic expansion valves, subcooling heat exchanger, refrigerant control piping and electronics to facilitate communications between unit and main processor and between branch unit and indoor/evaporator units.
 1. Control direction of refrigerant flow using electronic expansion valves; use of solenoid valves for changeover and pressure equalization is not permitted due to refrigerant noise; use of multi-port branch selector boxes is not permitted unless spare ports are provided for redundancy.
 2. Provide one electronic expansion valve for each downstream unit served, except multiple indoor/evaporator units may be connected, provided balancing joints are used in downstream piping and total capacity is within capacity range of the branch selector.
 3. When branch unit is simultaneously heating and cooling, energize subcooling heat exchanger.
 4. Casing: Galvanized steel sheet; with flame and heat resistant foamed polyethylene sound and thermal insulation.
 5. Refrigerant Connections: Braze type.
 6. Condensate Drainage: Provide unit that does not require condensate drainage.
 7. Products:
 - a. Daikin BSVQ Series.

2.6 INDOOR/EVAPORATOR UNITS

- A. All Indoor/Evaporator Units: Factory assembled and tested DX fan-coil units, with electronic proportional expansion valve, control circuit board, factory wiring and piping, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 1. Refrigerant: Refrigerant circuits factory-charged with dehydrated air, for field charging.
 2. Temperature Control Mechanism: Return air thermistor and computerized Proportional-Integral-Derivative (PID) control of superheat.
 3. Coils: Direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.
 - a. Provide thermistor on liquid and gas lines.
 4. Fans: Direct-drive, with statically and dynamically balanced impellers; high and low speeds unless otherwise indicated; motor thermally protected.
 5. Return Air Filter: Provide with MERV-13 filters and rack, minimum 2" thick, unless otherwise indicated on plans.
 6. Condensate Drainage: Built-in condensate drain pan with PVC or copper drain connection.
 - a. Units With Built-In Condensate Pumps: Provide condensate safety shutoff and alarm.

- b. Units Without Built-In Condensate Pump: Provide built-in condensate float switch and wiring connections where condensate route cannot be accomplished by gravity alone.
 - 7. Cabinet Insulation: Sound absorbing foamed polystyrene and polyethylene insulation.
- B. Concealed-In-Ceiling Units: Ducted horizontal discharge and return; galvanized steel cabinet.
 - 1. Return Air Filter: Manufacturer's standard.
 - 2. Sound Pressure: Measured at low speed at 5 feet (1.5 m) below unit.
 - 3. Provide external static pressure switch adjustable for high efficiency filter operation
 - 4. Condensate Pump: Built-in, with lift of 9 inches (229 mm), minimum.
 - 5. Switch box accessible from side or bottom.
 - 6. Product(s):
 - a. Daikin FXMQ_P Series; three-speed direct-drive DC (ECM) type fan with automatic airflow adjustment; external static pressure selectable during commissioning.
 - b. Daikin FXMQ_M Series; direct-drive Sirocco type fan.
- C. Wall Surface-Mounted Units: Finished white casing, with removable front grille; foamed polystyrene and polyethylene sound insulation; wall mounting plate; polystyrene condensate drain pan.
 - 1. Airflow Control: Auto-swing louver that closes automatically when unit stops; five (5) steps of discharge angle, set using remote controller; upon restart, discharge angle defaulting to same angle as previous operation.
 - 2. Sound Pressure Range: Measured at low speed at 3.3 feet (1 m) below and away from unit.
 - 3. Condensate Pump: Built-in, concealed.
 - 4. Condensate Drain Connection: Back, with piping concealed in wall.
 - 5. Fan: Direct-drive cross-flow type.
 - 6. Fan Motor Output Range: From 0.054 to 0.058 HP (40 to 43 W).
 - 7. Products:
 - a. Daikin FXAQ Series.
- D. Air Handling Units: Factory-painted heavy gauge steel casing insulated with sound absorbing foil faced insulation.
 - 1. Horizontal Right or Left Configuration (see plans): Horizontal discharge air and horizontal return air.
 - 2. Secondary condensate drain pan; field installed.
 - 3. Fan: Direct-drive ECM type fan with automatic airflow adjustment.
 - 4. Provide MERV 13 4" air filter.
 - 5. Products:
 - a. Daikin FXTQ Series.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that required electrical services have been installed and are in the proper locations prior to starting installation.
- B. Verify that condensate piping has been installed and is in the proper location prior to starting installation.
- C. Notify Architect if conditions for installation are unsatisfactory.

3.2 INSTALLATION

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

- B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
- C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
- D. Coordinate with installers of systems and equipment connecting to this system.
- E. perform a 50 PSI pneumatic pressure test for min. 48 hours to prove underground joints are water & air tight, leave gauges on during backfill to demonstrate integrity is maintained after burial.

3.3 FIELD QUALITY CONTROL

- A. See Division 1, for additional requirements.
- B. Store conduit to ensure all components stay dry prior to installation. Cover openings to prevent entry of water or debris during installation.
- C. Provide manufacturer's field representative to inspect installation prior to startup.

3.4 SYSTEM STARTUP

- A. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
- B. Adjust equipment for proper operation within manufacturer's published tolerances.

3.5 CLEANING

- A. Clean exposed components of dirt, finger marks, and other disfigurements.

3.6 COMMISSIONING

- A. See Division 1 for commissioning requirements.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 01 77 00 - Contract Closeout and Final Cleaning, for closeout submittals.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- C. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Manufacturer's training personnel or VRV equipment installer.
 - 4. Location: At project site.

3.8 PROTECTION

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

3.9 MAINTENANCE

- A. Provide a separate maintenance contract for specified maintenance service.

END OF SECTION

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SECTION 26 05 00
GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work of this Section consists of providing all required labor, supervision, materials and equipment (except equipment furnished by the Owner to be installed by the Contractor) to satisfactorily complete the work shown on the drawings and/or specified in all Sections of Division 26 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete and fully operating facility. The work shall include but not be limited to the following:
 - 1. Furnish and install all required in-place equipment, conduits, conductors, cables and any miscellaneous materials for the satisfactory interconnection and operation of all associated electrical systems.

1.2 RELATED WORK:

- A. This Section provides the basic Electrical Requirements which supplement the General Requirements of Division 1 and apply to all Sections of Division 26.

1.3 STANDARDS AND CODES:

- A. All work and material shall be in compliance with and according to the requirements of the latest revision of the following standards and codes:
 - 1. California Electrical Code (CEC)
 - 2. National Fire Protection Association (NFPA):
 - a. 70 National Electrical Code (NEC)
 - 3. American National Standards Institute (ANSI) Publications:
 - a. C2-02 National Electrical Safety Code
 - 4. Code of Federal Regulations (CFR):
 - a. 29 CFR 1910.147 Control of Hazardous Energy (Lock Out/Tag Out)
 - 5. Electronics Industries Association / Telecommunications Industries Association (EIA / TIA)
 - 6. Institute of Electrical and Electronics Engineers (IEEE)
 - 7. National Electrical Testing Association (NETA):
 - a. Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, Standard ATS
 - 8. National Electrical Manufacturers Association (NEMA)
 - 9. Occupational Safety and Health Act (OSHA) Standards
 - 10. State of California Public Utilities Commission:
 - a. General Order 128 Rules for Construction of Underground Electric Supply and Communication Systems
 - 11. Variances: In instances where two or more codes are at variance, the most restrictive requirement shall apply.
 - 12. Underwriter Laboratories (UL) listing is required for all equipment and materials where such listing is offered by the Underwriters Laboratories. Safety labeling and listing by other organizations, such as ETL Testing Laboratories, may be substituted for UL labeling and listing if acceptable to the Owner. Provide service entrance labels for all equipment required by the NEC to have such labels.

1.4 SUBMITTALS:

- A. As specified in Division 1. Submit to the Engineer shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system specified. Obtain approval before procurement, fabrication, or delivery of the items to the job site. Partial

- submittals are not acceptable and will be returned without review.
- B. Submittals are required for all items, regardless of whether they are furnished as specified or are substituted.
 - C. Submittals shall be provided prior to the purchasing and installation of the item(s) being submitted. Any work done prior to the final approval of the submittal shall be done at risk and any modifications, changes, or re-work that may be required resulting from the final submittal review shall be provided by the Contractor at no additional cost to the project.
 - D. Information to be submitted includes manufacturer's name, trade name, equipment model number, nameplate data, equipment drawings including: size, layout dimensions and capacity, manufacturer's descriptive literature of cataloged products, diagrams, fault and coordination study, seismic calculations, test data, and performance and characteristic curves as applicable. Furnish project specification and paragraph reference, applicable Federal, Industry and Technical Society Publication References, and years of satisfactory service of each item required to establish contract compliance. Photographs of existing installations and data submitted in lieu of catalog data are not acceptable and will be returned without approval.
 - E. If submittal information includes multiple products, items being submitted for approval shall be clearly identified and Items not to be used on the project shall be clearly marked out. Submittals consisting of manufacturer's catalogs without clearly marking out items not being used will be returned as not reviewed.
 - F. Organize submittals for equipment and items related to each specification section together as a package.
 - G. Submit submittal packages in digital PDF format.
 - 1. Certificates of Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this contract. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements that imply the item does not meet requirements specified, such as "as good as", "achieve the same end use and results as materials formulated in accordance with the referenced publications;" or "equal or exceed the service and performance of the specified material." Certifications shall state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official, authorized to sign certificates of conformance.
 - H. Substitutions:
 - 1. The equipment included in the Contract Documents is used to establish standards of quality, utility, size, and appearance. Equipment which in the opinion of the Engineer is equal in quality, utility, size, and appearance will be approved as substitutions to that specified.
 - a. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are approved by the Engineer prior to bidding.
 - 2. Substitutions will be accepted for review where there is a reasonable reason for the substitution. Reasonable reasons include:
 - a. Cost savings to the Owner. Include deductive change order with submittal.
 - b. A product with features providing additional benefits to the end user.
 - c. Improved finished environment, lay out of the final installation, or space savings over the specified equipment.
 - d. Delivery considerations.
 - e. Owner's specific requests.

3. Where items are noted as “or equal”, a product of equal design, construction and performance will be considered.
 4. Any item proposed as a substitute shall be accompanied by the following:
 - a. Drawings and/or data giving sizes, capacities, all pertinent test data, catalog cut sheets, product information, and all other necessary information required to substantiate that the product is equal or exceeds that specified.
 - b. A summary sheet noting each performance characteristic noted in the specification section or elsewhere in the contract documents of the specified product and the corresponding performance characteristics of the proposed substitution. The summary sheet shall contain the following information:
 - 1) Reason for Substitution Request
 - 2) Pertinent Performance Characteristics
 - 3) Specified Product Values
 - 4) Substituted Product Values
 - c. Any substitution request that does not include the above information shall be rejected.
 - d. Refer to the end of this specification section for an example form to be used for substituted products. A Microsoft Word version of the form can be provided to the Contractor for their use upon request.
 5. Substitutions shall be equal, in the opinion of the Engineer, to the specified equipment. The burden of proof of such shall rest with the Contractor. When the Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted equipment to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the work, or from any provisions of the Plans or Specifications.
 6. Contractor shall be responsible for coordination of the substituted products with other trades. Provide all additional connectivity, equipment, increased wire/conduit size, installation hardware, testing, and other miscellaneous appurtenances as required for a complete and fully functional installation.
 7. Only one substitution will be considered for each product specified.
 8. Alternate manufacturers must be submitted for approval 10 days prior to bid date unless noted otherwise in Division 1.
 9. The Contractor shall be responsible for all expenses in connection with the substitution materials, process, and equipment, including the effect of his/her substitution on him/her, his/her sub-Contractor’s or other Contractor’s work. No substitution shall be permitted without written authorization of the Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.
- I. Change Orders:
1. Where a change to the contract documents would result in a credit due to the Owner or a value add change to the project, provide a detailed change order request for the Engineer to review.
 2. It shall be understood that the Engineer’s review of costs associated with the change order shall not constitute approval of the change order or their associated costs. The Engineer’s review shall be intended to assist the Owner in evaluating the costs associated with the change only. Final approval or rejection of the change order shall be at the discretion of the Owner.
 3. Change order requests shall include the following information:
 - a. Description of the change
 - b. Reference to the document or written direction to make the change:

- 1) In the case of design-team directed changes, reference the drawing/sketch number or RFI number.
- 2) In the case of Owner-directed changes, reference the email, memo, or other written direction from the Owner and provide a copy of the direction.
- c. Detailed cost breakdown for the change:
 - 1) Line item for each material noting:
 - (a) Material used (e.g. 3/4" EMT)
 - (b) Total quantity (e.g. 200lf)
 - (c) Unit cost (e.g. \$2/lf)
 - (d) Total materials cost (e.g. \$400)
 - (e) Unit labor hours (e.g. 6hrs/100lf)
 - (f) Total labor hours (e.g. 12hrs)
 - (g) Hourly rate (e.g. \$90/hr)
 - (h) Total labor cost (e.g. \$1,080)
 - 2) Total labor hours for each position (e.g. Journeyman vs. Superintendent)
 - 3) Total materials cost
 - 4) Overhead
 - 5) Profit
 - 6) Total change order value (positive for value added changes, negative for credits)
- J. Closeout Submittals:
 1. As-built drawings: Submit As-Built Record documents as in accordance with section 3.05 below.
 2. Cost analysis: Submit final cost information including original bid and any change orders broken down by system, material and labor costs (as applicable):
 - a. Power distribution
 - b. Lighting and lighting controls
 - c. Low Voltage systems
 3. Operation and Maintenance Manuals: Furnish O & M Manuals for equipment where manuals are specified in the equipment specifications or are specified in Division 1. Electrical O & M Manuals shall be provided in a single transmittal and shall include as a minimum:
 - a. Copies of equipment supplied on the project.
 - b. Instruction manuals including operation instructions and maintenance requirements/recommendations.
 - c. List of suppliers for all equipment with addresses and telephone numbers.
 - d. List of service support for all equipment with addresses and telephone numbers.
 - e. Copies of all test reports required in Division 26 specification sections.
 - f. Spare Parts: For each piece of equipment, submit a list of recommended spare parts. Include part numbers and the name, address, and telephone number of the supplier.
 - g. Other closeout documentation and test results as required under other sections of the specifications.
 - h. Warranty for all work, equipment, and systems, including Contractor's general warranty.
 - i. All warranties begin as per the Contract, Division 1 or final acceptance of the Work by the Owner, Architect, Engineer, and Authority Having Jurisdiction, which ever is later.
 - 1) Lamps, drivers, and ballasts are to be covered as per specification 26 50 00.
 - 2) Manufacturer's Warrantees and Guarantees that are longer than the base contract/specified amount are to be provided with the manuals.

- 3) The Contractor is responsible for all Warranty and Guarantee work whether or not the Manufacturer also Warrantees and Guarantees the product.

1.5 CONTRACT DOCUMENTS:

- A. Review the Drawings and Specification Divisions of other trades and perform the electrical work that will be required for the installations.
 1. Should there be a need to deviate from the Electrical Drawings and Specifications, submit written details and reasons for all changes to the Engineer for favorable review.
 2. All drawings and divisions of these specifications shall be considered as whole. This Contractor shall report any apparent discrepancies prior to submitting bids.
 3. Should there be a conflict or discrepancy between the drawings and specifications, or between different drawings sheets, or between different specification sections, the most expensive option shall be required, at the discretion of the Engineer.
- B. Drawings:
 1. The Drawings shall govern the general layout of the completed construction:
 - a. Locations of equipment, inserts, anchors, panels, pullboxes, manholes, conduits, stub-ups, fittings, power and convenience outlets, lighting fixtures and ground connections are approximate unless dimensioned; verify locations with the Engineer prior to installation. Field verify scaled dimensions on Drawings.
 - b. The general arrangement and location of existing conduits, piping, apparatus, etc., is shown as existing on drawings or specified. The drawings and specifications are for the assistance and guidance of the Contractor, exact locations, distances and elevations are governed by actual field conditions. Extreme accuracy of data given herein and on the drawings is not guaranteed. Minor changes may be necessary to accommodate work. The Contractor is responsible for verifying existing conditions. Should it be necessary to deviate from the design due to interference with existing conditions or work in progress, claims for additional compensation shall be limited to those for work required by unforeseen conditions as determined by the Engineer.

1.6 COORDINATION:

- A. Coordinate the electrical work with the other trades, code authorities, utilities and the Engineer:
 1. Failure to accomplish this coordination is not a basis for additional cost reimbursement to the Contractor.
 2. Coordinate does not mean to only send a Request For Information. Coordinate implies that the Contractor is to take the lead in bringing all of the necessary organizations together to coordinate the work and to provide for the associated costs.
- B. Where connections must be made to existing installations, properly schedule all the required work, including the power shutdown periods. Schedule and carry out shutdowns so as to cause the least disruption to operation of the Owner's facilities:
 1. Include costs for work during non-normal working hours and temporary facilities as may be required.
 2. Include costs as necessary for sub-Contractors as necessary to accomplish the specified work.
- C. When two trades join together in an area, make certain that no electrical work is omitted. Failure to accomplish this coordination is not a basis for additional cost reimbursement to the Contractor.
- D. Operations:
 1. Perform all work in compliance with Division 1:
 - a. Keep the number and duration of power shutdown periods to a minimum.
 - b. All shutdowns which would interfere with the operations of Owner's equipment or facilities shall be coordinated with the Owner a minimum of 15 days in advance.

- 1) Where Owner's equipment or facilities must remain operational during the shutdown, provide sufficient means to temporarily backup the interrupted services for the duration of the interruption.
 - c. Show all proposed shutdowns and their expected duration on the construction schedule.
 - 1) If the construction schedule is created and maintained by others, make sure that the associated information is incorporated.
 - 2) Failure by the Contractor to properly schedule and plan for such activities is not a basis for additional compensation.
 - d. Carry out shutdown only after the Engineer has favorably reviewed the schedule. Submit power/communications interruption schedule 15 days prior to date of interruption. Failure to provide schedule with adequate review time may result in rescheduling of the work at the Contractor's expense.
 - E. Construction Power:
 1. See Division 1 Temporary Utilities.
 - F. Storage:
 1. Provide adequate storage for all equipment and materials which will become part of the completed facility so that it is protected from sun, weather, condensation, dust, water, or construction operations.
 - G. Damaged Products:
 1. Notify the Engineer in writing in the event that any equipment or material is damaged. Obtain approval from the Engineer and Manufacturer before making repairs to damaged products.
 - H. Order material in such a timely manner and after approval of the same so as to insure that the approved material is available to be installed on site in a timely manner. Additional costs or substitutions necessitated because the Contractor failed to order material in a timely manner are not reimbursable. Costs associated with processing of paperwork by the Owner and design consultants resultant of such failures to coordinate the work by the Contractor shall have such costs reimbursed by the Contractor.
- 1.7 LOCATIONS:
 - A. General: Use equipment, materials and wiring methods suitable for the types of locations in which they are located.
 1. Dry Locations:
 - a. All those indoor areas which do not fall within the definition below for Wet Locations and which are not otherwise designated on the Drawings.
 2. Wet Locations:
 - a. All locations exposed to the weather or contact with water (such as kitchen areas subject to directional water spray as a means of cleaning surfaces), whether under a roof or not, unless otherwise designated on the Drawings.
- 1.8 SAFETY AND INDEMNITY:
 - A. Lock out Requirements:
 1. Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147
 - B. The Contractor is solely and completely responsible for conditions of the job site including safety of all persons and properly during performance of the work. This requirement will apply continually and not be limited to normal working hours.
 1. No act, service, drawing review or construction review by the Owner, the Engineer or their Consultants is intended to include reviews of the adequacy of the Contractors safety

measures in or near the construction site.

2. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify, and defend the Owner, the Engineer, their consultants, and each of their officers, agents and employees from any and all liability claims, losses, or damage arising out of or alleged to arise from bodily injury, sickness, or death of a person or persons and for all damages arising out of injury to or destruction of property arising directly or indirectly out of or in connection with the performance of the work under this Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the construction contract documents, but not including liability that may be due to the sole negligence of the Owner, the Engineer, their Consultants or their officers, agents and employees.

PART 2 PRODUCTS

2.1 STANDARD OF QUALITY:

- A. Material and Equipment: Provide materials and equipment that are new and are current products of manufacturers regularly engaged in the production of such products. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year period includes use of equipment and materials of similar size under similar circumstances. For uniformity, only one manufacturer will be accepted for each type of product.
- B. Service Support: Submit a certified list of qualified permanent service organizations including their addresses and qualification for support of the equipment. These service organizations shall be convenient to the equipment installation and able to render service to the equipment on a regular and emergency basis during the warranty period of the contract.
- C. Manufacturer's Recommendations: Where installation procedures are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendation shall be cause for rejection of the equipment or material.

2.2 FASTENERS:

- A. Fasteners for securing equipment to walls, floors and the like shall be either hot-dip galvanized after fabrication or stainless steel.

2.3 FINISH REQUIREMENTS:

- A. Equipment: Refer to each electrical equipment section of these Specifications for painting requirements of equipment enclosures. Repair any final paint finish which has been damaged or is otherwise unsatisfactory, to the satisfaction of the Engineer.
- B. In finished areas, paint all exposed conduits, boxes and fittings to match the color of the surface to which they are affixed.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Ensure that all equipment and materials fit properly in their installation.
- B. Perform any required work to correct improperly fit installation at no additional expense to the Owner.
- C. Equipment Installation:
 1. Provide the required inserts, bolts and anchors, and securely attach all equipment and materials to their supports.
 2. In all rooms with concrete floors, install all floor mounted equipment on reinforced concrete pads as shown. Insure that pads are seismically secured to the building structure.

The Contractor, suppliers, and fabricators shall take this requirement into consideration when designing, fabricating, and installing panels and other enclosures so that height above the floor of the operating handles of electrical devices meets the requirements of these Specifications and applicable codes.

3. Mount all metal panels which are mounted on or abutting concrete walls or any outside walls a minimum of ¼ inch from the wall, and paint the back sides of the panels with Bituminous Coating, Rust-oleum C9578 Coal Tar Epoxy Coating or approved equal. Film thickness shall be 10 mils minimum.

D. Cutting, Drilling and Welding:

1. Provide the required cutting, drilling welding that is required for the electrical construction work. Comply with Division 1 requirements.
2. Structural members shall not be cut or drilled, except after approval by the Engineer. Use a core drill wherever it is necessary to drill through concrete or masonry.
3. Provide the required welding for equipment supports. Conduits and fittings shall not be welded to structural steel. Where welding is required, it shall be accomplished by tradesmen certified to do such work. Provide fire and other protection as appropriate.

3.2 FIELD TESTS:

- A. Test shall be in accordance with Acceptance Testing specifications issued by the National Electrical Testing Association (NETA).
- B. Perform equipment field tests and adjustments. Properly calibrate, adjust and operationally check all circuits and components, and demonstrate as ready for service. Perform each operational check three times to ensure the circuit and components are working properly. Make additional calibration and adjustments if it is determined later that the initial adjustments are not satisfactory for proper performance. Perform equipment field test for equipment where equipment field tests are specified in the equipment Specifications. Give sufficient notice to the Engineer prior to any test so that the tests may be witnessed.
- C. Provide instruments, other equipment, temporary facilities as may be necessary, and material required for the tests. These shall be of the type designed for the type of tests to be performed and shall be calibrated by a recognized testing laboratory within three months prior to testing.
- D. Operational Tests: Operationally test all circuits to demonstrate that the circuits and equipment have been properly installed and adjusted and are ready for full-time service. Demonstrate the proper functioning of circuits in all modes of operation, including alarm conditions.
- E. Re-testing will be required for all unsatisfactory tests after the equipment or system has been repaired. Re-test all related equipment and systems if required by the Engineer. Repair and re-test equipment and systems which have been satisfactorily tested but later fail, until satisfactory performance is obtained.
- F. Perform calibration and adjustment on all equipment. Where the values for adjustment are not shown on the Drawings, obtain the proper values from the Engineer.
- G. Maintain records of each test and submit five copies to the Engineer when testing is complete. All tests shall be witnessed by the Owner and/or Engineer at their discretion. These records shall include:
 1. Name of equipment tested.
 2. Date of report.
 3. Date of test.
 4. Description of test setup.
 5. Identification and rating of test equipment.
 6. Test results and data.
 7. Name of person performing test.
 8. Owner or Engineer's initials.

H. Items requiring testing as a minimum:

1. Ground field grid.
2. Circuit Breakers.

3.3 PAINTING OF EQUIPMENT:

- A. Factory Applied: Electrical equipment shall have factory applied painting system which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test and the additional requirements specified in the technical section.
- B. Field Applied: Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.4 RECORDS:

- A. Maintain one copy of the contract Drawing Sheets on the site of the work for recording the record “as built” condition. After completion of the work, the Contractor shall neatly and carefully mark the work as actually constructed, revising, deleting and adding to the Drawing Sheets as required. The following requirements shall be complied with:
 1. Drawings and associated as-built changes shall be completed in AutoCAD or Revit and submitted in CAD/Revit as well as PDF format. Documents with hand-written changes or with RFI responses and field sketches pasted on shall not be acceptable. Engineer shall make digital backgrounds of original contract documents available for Contractor’s use upon request.
 2. Cable Size and Type: Provide the size and type of each cable installed on the project.
 3. Substructure: Where the location of duct lines, adjacent utilities, cable boxes, and manholes are found to differ than shown, carefully mark the correct location on the Drawings. Work shall be dimensioned from existing improvements.
 4. Record (As Built) Drawings: At the completion of the Work the Contractor shall provide a set of record “as built” drawings over to the Owner for his use.
 - a. Record drawings are required to be transmitted within 30 days of beneficial occupancy.
 - b. Transmittal and approval process:
 - 1) Contractor is to transmit one digital copy for review and comment.
 - 2) After acceptance of the above, the Contractor is to transmit three printed sets and one digital reproducible set.
 - 3) Contractor to provide information on their company in the margin of record drawings along with the date of the revisions and the associated revision number.

3.5 POSTED OPERATING INSTRUCTIONS:

- A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
 1. Single line diagrams, wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment at each major piece of distribution equipment.
 2. Start up, proper adjustments, operating, lubrication and shutdown procedures.
 3. Safety precautions.
 4. The procedure in the event of equipment failure.
 5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.
- B. Instruction to Owner’s Personnel:
 1. Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance

of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or systems has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for field instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

2. Contractor shall video record all training sessions and shall provide the Owner with a copy of the recording at the conclusion of the training. Recording shall be in digital video format (MP4, AVI, or similar) and shall be provided on USB stick or DVD labeled with the Contractor's contact information, the training topic, and date of training.
3. Contractor shall maintain an attendance sheet from each session which contains the following information:
 - a. Attendees with associated arrival and departure time.
 - b. Topics covered.
 - c. Information provided.
 - d. Signatures of attendees taken at the completion of the session.

3.6 CLEAN UP:

- A. Thoroughly clean all soiled surfaces of installed equipment and materials, including, but not limited to, removal of all dirt, dust, debris, and unused construction materials.
- B. Upon completion of electrical work, remove all surplus materials, rubbish, and debris that accumulated during the construction work. Leave the entire area neat, clean, and acceptable to the Engineer.

(1)

(2) **Substitution Request Form**

(3)

(4) Project Name: _____

(5) Request Date: _____

(6)

(7) Submittal Name: _____

(8) Submittal Number: _____

(9)

(10) Reason for Substitution Request (check all that apply):

(11)

| Reason | Additional Information |
|--|--|
| <input type="checkbox"/> Cost savings to the owner | <i>(Note cost savings here)</i> |
| <input type="checkbox"/> A product with features providing additional benefits to the end user | <i>(Note benefits here)</i> |
| <input type="checkbox"/> Improved finished environment, lay out of the final installation, or space savings over the specified equipment | <i>(Note benefits here)</i> |
| <input type="checkbox"/> Delivery considerations | <i>(Note schedule savings here)</i> |
| <input type="checkbox"/> Owner's specific requests | <i>(Note requested change and who made request here)</i> |

(12)

(13) Product Data Information (provide one line per performance characteristic):

| Property | Specified | Substitution | Meets | Exceeds |
|------------------------------|---------------------|---------------------|-------------------------------------|--------------------------|
| <i>(e.g. Thermal Rating)</i> | <i>(e.g. 90° C)</i> | <i>(e.g. 90° C)</i> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> |
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| | | | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | | |
|--|--|--|--------------------------|--------------------------|
| | | | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | <input type="checkbox"/> | <input type="checkbox"/> |

(14)

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Underground feeder and branch-circuit cable.
- C. Service entrance cable.
- D. Wiring connectors.
- E. Electrical tape.
- F. Heat shrink tubing.
- G. Oxide inhibiting compound.
- H. Wire pulling lubricant.
- I. Cable ties.
- J. Firestop sleeves.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- B. Section 26 05 53 - 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 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF) 2007.
- I. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy 2021.
- J. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.
- K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 44 - Thermoset-Insulated Wires and Cables Current Edition, Including All Revisions.

- M. UL 83 - Thermoplastic-Insulated Wires and Cables Current Edition, Including All Revisions.
- N. UL 486A-486B - Wire Connectors Current Edition, Including All Revisions.
- O. UL 486C - Splicing Wire Connectors Current Edition, Including All Revisions.
- P. UL 486D - Sealed Wire Connector Systems Current Edition, Including All Revisions.
- Q. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables Current Edition, Including All Revisions.
- R. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape Current Edition, Including All Revisions.
- S. UL 854 - Service-Entrance 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 01 30 00 - 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. 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. 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.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- 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 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, 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. Nonmetallic-sheathed cable is not permitted.
- D. Armored cable is not permitted.
- E. Metal-clad cable is not permitted.

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. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- H. 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.
- I. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- K. 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.
- c. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. General Cable Technologies Corporation; [_____]: www.generalcable.com/#sle.
 - c. Southwire Company: www.southwire.com/#sle.
- 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, except as indicated below.
 - a. Size 6 AWG and Larger: Type XHHW-2.
 - b. Installed Underground: Type XHHW-2.
 - c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.4 UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE

- A. Manufacturers:
 - 1. Southwire Company: www.southwire.com/#sle.
- B. Description: NFPA 70, Type UF multiple-conductor cable listed and labeled as complying with UL 493, Type UF-B.
- C. Provide equipment grounding conductor unless otherwise indicated.
- D. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- E. Insulation Voltage Rating: 600 V.

2.5 SERVICE ENTRANCE CABLE

- A. Manufacturers:
 - 1. Copper Service Entrance Cable:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. Southwire Company: www.southwire.com/#sle.
- B. Service Entrance Cable for Above-Ground Use: NFPA 70, Type SE multiple-conductor cable listed and labeled as complying with UL 854, Style R.
- C. Service Entrance Cable for Underground Use: NFPA 70, Type USE single-conductor cable listed and labeled as complying with UL 854, Type USE-2, and with UL 44 Type RHH/RHW-2.
- D. Conductor Stranding: Stranded.

E. Insulation Voltage Rating: 600 V.

2.6 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 26 05 26.
- 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.
- D. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 2. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 3. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 4. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors where connectors are required.
 5. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
 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. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
 - a. Burndy LLC; [_____]: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
- I. 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.

2.7 ACCESSORIES

- A. Electrical Tape:
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.

2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Burndy LLC; [_____]: www.burndy.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
1. Manufacturers:
 - a. Burndy LLC; [_____]: www.burndy.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. IlSCO: www.ilsco.com/#sle.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. American Polywater Corporation: www.polywater.com/#sle.
 - c. Ideal Industries, Inc: www.idealindustries.com/#sle.
- E. Cable Ties: Material and tensile strength rating suitable for application.
1. Manufacturers:
 - a. Burndy LLC; [_____]: www.burndy.com/#sle.
- F. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.
1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
- G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.

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. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 4. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 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 underground feeder and branch-circuit cable (Type UF-B) in accordance with NECA 121.
- E. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Exposed Cable Installation (only where specifically permitted):
 - 1. Route cables parallel or perpendicular to building structural members and surfaces.
 - 2. Protect cables from physical damage.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
 - I. Terminate cables using suitable fittings.
 - J. Install conductors with a minimum of 12 inches of slack at each outlet.
 - K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
 - L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
 - M. 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.
 - N. 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.
 - O. Insulate ends of spare conductors using vinyl insulating electrical tape.
 - P. 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.
 - Q. Identify conductors and cables in accordance with Section 26 05 53.
 - R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
 - S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- 3.4 FIELD QUALITY CONTROL
- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
 - B. Inspect and test in accordance with NETA ATS, except Section 4.
 - C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.

1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing.
Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

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SECTION 26 05 26 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.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground plate electrodes.
- G. Ground access wells.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

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. NEMA GR 1 - Ground Rod Electrodes and Ground Rod Electrode Couplings 2017.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.
- E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 467 - Grounding and Bonding Equipment Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- 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.
- D. Field quality control test reports.

- E. Project Record Documents: Record actual locations of grounding electrode system components and connections.

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.
- 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 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. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Concrete-Encased Electrode:

- a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
4. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - d. Provide ground access well for each electrode.
5. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
6. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- G. Service-Supplied System Grounding:
 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
 1. Provide grounding electrode system for each separate building or structure.
 2. Provide equipment grounding conductor routed with supply conductors.
 3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
- I. Bonding and Equipment Grounding:
 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
 8. Provide bonding for metal building frame.
- J. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

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 26 05 26:
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 exothermic welded connections for accessible connections.
 4. Manufacturers - Exothermic Welded Connections:
 - a. Cadweld, a brand of Erico International Corporation; [_____]: www.erico.com/#sle.
- D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: As indicated.
 3. Holes for Connections: As indicated or as required for connections to be made.
 4. Manufacturers:
 - a. Erico International Corporation; [_____]: www.erico.com/#sle.
- E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.

2. Material: Copper-bonded (copper-clad) steel.
 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
 4. Manufacturers:
 - a. Erico International Corporation; [_____]: www.erico.com/#sle.
- F. Ground Plate Electrodes:
1. Material: Copper.
 2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.
- G. Ground Access Wells:
1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
 2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
 4. Cover: Factory-identified by permanent means with word "GROUND".
 5. Manufacturers:
 - a. Erico International Corporation; [_____]: www.erico.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. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
 2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
- D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.
- E. Make grounding and bonding connections using specified connectors.
 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

F. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 33.16 - Boxes for Electrical Systems.
- E. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.
- H. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems conduits.

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) 2013.
- E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) 2017.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- G. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit 2020.
- H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing 2021.
- I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 1 - Flexible Metal Conduit Current Edition, Including All Revisions.
- K. UL 6 - Electrical Rigid Metal Conduit-Steel Current Edition, Including All Revisions.

- L. UL 360 - Liquid-Tight Flexible Metal Conduit Current Edition, Including All Revisions.
- M. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.
- N. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings Current Edition, Including All Revisions.
- O. UL 797 - Electrical Metallic Tubing-Steel Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

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

3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
 6. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges.
- D. Embedded Within Concrete:
1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use rigid PVC conduit.
 2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use rigid PVC conduit.
 3. Within Concrete Walls Above Ground: Use rigid PVC conduit.
 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
- E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit.
- L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.
- M. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
1. Maximum Length: 6 feet.
- N. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit.
 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 3. Maximum Length: 6 feet unless otherwise indicated.
 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
- ## 2.2 CONDUIT REQUIREMENTS
- A. Electrical Service Conduits: Also comply with Section 26 21 00.
 - B. Communications Systems Conduits: Also comply with Section 27 10 00.
 - C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.
 - D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
 - E. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - F. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4 inch (21 mm) trade size.
 2. Underground, Interior: 1 inch (27 mm) trade size.
 3. Underground, Exterior: 1 inch (27 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: www.alliedeg.com/#sle.
- B. Conduit with integral fittings, such as Allied Tube and Conduit's "Kwik-Fit" are not permitted.
- C. Conduits shall be color-coded based on the wiring or system type they serve. Paint shall be factory applied by the manufacturer
1. Normal Power Systems: No color
 2. Emergency and Standby Power Systems: Yellow
 3. Fire Alarm: Red
 4. Security: Orange
 5. Telephone and Data: Blue
 6. Audio/Visual: Purple
 7. Other Low Voltage: Green
- D. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- E. Fittings:
1. Manufacturers:
 - a. Thomas & Betts Corporation: www.tnb.com/#sle.
 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc; [_____]: www.afcweb.com/#sle.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
1. Manufacturers:
 - a. Thomas & Betts Corporation: www.tnb.com/#sle.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc; [_____]: www.afcweb.com/#sle.
- 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. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.6 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit; [_____]: www.alliedeg.com/#sle.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Manufacturers:
 - a. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 4. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.

2.7 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

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

2.8 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.
- G. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations

where applicable.

1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
- H. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
 1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
- I. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for the conduit/duct arrangement to be installed.
- 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.
- K. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for the casing and conduit/duct arrangement to be installed.
 1. Products:
 - a. Advance Products & Systems, LLC; Bore Spacers: www.apsonline.com/#sle.

PART 3 EXECUTION

3.1 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. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- E. Conduit Routing:
 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 2. When conduit destination is indicated without specific routing, determine exact routing required.
 3. Conceal all conduits unless specifically indicated to be exposed.
 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across top of parapet walls.
 - c. Across building exterior surfaces.

6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 8. For power conduits, arrange conduit to provide no more than the equivalent of three 90 degree bends between pull points.
 9. For low voltage conduits, arrange conduit to provide no more than the equivalent of two 90 degree bends between pull points.
 10. Arrange conduit to provide no more than 150 feet between pull points.
 11. Route conduits above water and drain piping where possible.
 12. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 13. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 14. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 15. Group parallel conduits in the same area together on a common rack.
- F. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
 9. Use of spring steel conduit clips for support of conduits is not permitted.
 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 the most stringent requirements.
- G. 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. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- H. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. 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. Include proposed locations of penetrations and methods for sealing with submittals.
 8. Provide metal escutcheon plates for conduit penetrations exposed to public view.
 9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- I. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 23 16.13.
 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
- J. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Secure conduits to prevent floating or movement during pouring of concrete.
- K. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
- L. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- M. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- N. Provide grounding and bonding in accordance with Section 26 05 26.
- O. Identify conduits in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - 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 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Floor boxes.
- E. Underground boxes/enclosures.
- F. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 33.13 - 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 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.
 - 2. Access floor 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 FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports 2013 (Reaffirmed 2020).
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. SCTE 77 - Specifications for Underground Enclosure Integrity 2017.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- J. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.
- K. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.

1.4 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 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, 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 01 60 00 - 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.
- 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 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, 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 suitable concrete type boxes where flush-mounted in concrete.
 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 6. Use shallow boxes where required by the type of wall construction.
 7. Do not use "through-wall" boxes designed for access from both sides of wall.
 8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 10. 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.
 11. Gangable or sectional boxes shall not be permitted.
 12. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
 - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
 13. Wall Plates: Comply with Section 26 27 26.
 14. Manufacturers:
 - a. Thomas & Betts Corporation; [_____]: www.tnb.com/#sle.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:
 - a. Hoffman, a brand of Pentair Technical Products; [_____]: www.hoffmanonline.com/#sle.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
1. Recessed Wall Boxes: In-wall recessed box for the installation of power and low voltage devices behind flat panel displays.
 - a. Provide quantity of gangs as required to feed all power and low voltage devices as shown on plans.

- b. Low voltage j-box shall accommodate standard Decora style devices in addition to manufacturer's Intelligent Plate Solutions (IPS) devices. Refer to plans for types and quantities of connectors.
 - c. Box shall sit flush with wall, with cover provided over box opening. Cover shall be provided with cable pass-thru.
 - d. Cover color shall be white, unless otherwise noted.
 - e. Manufacturers:
 - 1) FSR Inc; PWB-100 Series: www.fsrinc.com/
2. Recessed Ceiling Boxes: Recessed in-ceiling box for installation of power and low voltage devices to serve a ceiling mounted projector.
- a. Enclosure shall come standard with (5) 120V outlets, with two duplex and one single outlet. Duplex outlets shall be located within enclosure, single outlet shall be located at the ceiling plane on the exterior of the box.
 - b. Enclosure shall be intended for installation in standard T-bar ceiling grid, with optional mounting kit option for drywall installation. Housing shall be constructed of steel. Provide ceiling tile, cut to size and finish to match adjacent ceiling, for installation in door of enclosure.
 - c. Enclosure shall be provided with optional fan kit.
 - d. Where the installed enclosure is intended to serve a projector, provide projector pole mount option. Pole mount shall be 1-1/2" National Pipe Thread (NPT) fitting, capable of supporting up to 50lbs.
 - e. Provide cable mounting kit for mounting of enclosure to ceiling structure above.
 - f. Provide additional threaded rod mounting kit as required for mounting conditions. Threaded rod kit shall accept 1/4" and 3/8" threaded rod at four hangar bracket locations.
 - g. Manufacturers:
 - 1) Ceiling Enclosure: FSR Inc.; CB-12P with CB-12FAN and CB-MNT1 series : www.fsrinc.com/
3. Recessed Floor Boxes for Concrete Floors:
- a. 11-gauge steel housing, suitable for installation in poured concrete floor applications.
 - b. Cover shall have hinged access door with solid metal "U" handle and integrated cable pass thru window. Pass-thru window opens down into box to avoid tripping hazards.
 - c. Transformable box bottom (for eight gang configurations only) with fully configurable gang plate dividers, compartment dividers, and center dividers. Provide arrangement of interior compartments as required to accommodate all devices indicated on plans and to separate voltages.
 - d. Provide manufacturer's brackets as required to accommodate all power and low voltage devices within each floor box.
 - e. Provide optional mitered brass carpet edging for installations in carpeted areas.
 - f. For areas with concrete, wood, or tile floors, install box such that finished floor is flush with the top edge of the box cover. Provide shim kit to install top of box flush with top of finished floor.
 - g. Provide manufacturer's concrete pour pan as required for proper installation.
 - h. Manufacturer:
 - 1) FSR Inc. FL-500-P series floor box, with FL-500P-BLP-C U-Access tile and carpet cover ; www.fsrinc.com/
4. Exterior In-Grade Floor Boxes
- a. Outdoor ground boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet NEMA 6P and IP68 requirements to be safe to use even during inclement weather and bear the UL Listing Mark.

- b. Outdoor ground boxes shall be designed to trap and maintain an air pocket to protect the devices, plugs and connections from water, snow, and ice. Boxes shall be constructed from UV rated chemical resistant materials. Boxes designed to ANSI/SCTE 77 with a Tier 5 rating to hold up to 5000 lbs of load. Boxes install flush to finished ground reducing tripping hazards. Box shall have a diving bell concept to maintain an air pocket and keep water away from connections. Box shall have an egress door that will auto-adjust to cable diameter and auto-lock in the closed position when no cables are exiting the box.
 - c. Provide quantity of enclosures as required to accommodate all devices noted on plans.
 - d. Provide manufacturer's brackets as required to accommodate all power and low voltage devices within each floor box.
 - e. Box covers shall come with pre-wired and installed electrical devices. Refer to plans for configuration of devices in each box.
 - 1) General: Single service 2-gang ground box manufactured from UV rated nonmetallic material. Box accepts up to two 1-1/4" trade size PVC conduit feeds. Boxes designed to be installed separately or ganged together for greater capacity and flexibility. Accepts optional cover assembly (see options below).
Box assemblies include main box body, installation cap, and installation plate.
 - 2) 125V, 20A, 1P Devices: Assembly prewired with two (2) 20A L5-20R weather-resistant duplex receptacles. Cover assembly includes flange, cover, junction box, (2) 20A 5-20R receptacles, SOOW cord, wet location wire connectors, key, and mounting hardware.
 - 3) 125V, 30A, 1P Devices: Assembly prewired with one (1) 30A L5-30R 120V corrosion-resistant duplex receptacle. Cover assembly includes flange, cover, junction box, SOOW cord, L5-30R receptacle, wet location wire connectors, key, and mounting hardware.
 - 4) 250V, 30A, 2P Devices: Assembly prewired with one (1) 30A L6-30R 208V corrosion-resistant duplex receptacle. Cover assembly includes flange, cover, junction box, SOOW cord, L6-30R receptacle, wet location wire connectors, key, and mounting hardware.
 - 5) Low Voltage Devices: Assembly designed to accept up to 12 communication ports or eight (8) manufacturer's audio/visual devices. Cover assembly includes flange, cover, junction box, corrugated conduit assembly, (1) 12 port communication mounting plate, (1) 8 port manufacturer's audio/video mounting plate, key, and mounting hardware.
 - f. Manufacturer:
 - 1) Enclosure: Legrand XB814 series ; www.legrand.com/
 - 2) Interior: 125V, 20A, 1P Devices: Legrand XB814C520BK, 125V, 30A, 1P Devices: Legrand XB814CL530BK, 250V, 30A, 2P Devices: Legrand XB814CL630BK, and Low Voltage Devices: Legrand XB814CLVBK
- E. Underground Boxes/Enclosures:
1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
 2. Size: As indicated on drawings.
 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
 4. Provide logo on cover to indicate type of service. Covers shall read as follows for each system type:
 - a. Power Systems: "ELECTRICAL"
 - b. Site Lighting and/or Pole Lighting: "LIGHTING"

- c. Fire Alarm Systems: "FIRE ALARM"
- d. Other Low Voltage Systems: "COMMUNICATIONS"
- e. Utility: Per utility company requirements
- 5. Applications:
 - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.
 - b. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
- 6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
 - a. Manufacturers:
 - 1) Oldcastle Precast, Inc; [_____]: www.oldcastleprecast.com/#sle.
 - b. Combination fiberglass/polymer concrete boxes/enclosures are not acceptable. Use all-polymer concrete boxes/enclosures.

2.2 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.
 - 1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.

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 08 31 00 as required where approved by the Architect.
 - 2. Unless dimensioned, box locations indicated are approximate.
 - 3. Locate boxes so that wall plates do not span different building finishes.
 - 4. Locate boxes so that wall plates do not cross masonry joints.
 - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.

6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
 10. Outlet boxes shall be installed at the locations and elevations shown on the drawings or specified herein. Make adjustments to locations as required by structural conditions and to suit coordination requirements of other trades.
 11. Locate switch outlet boxes on the latch side of doorways unless otherwise indicated.
 12. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 13. Outlet boxes shall not be installed back to back nor shall through-wall boxes be permitted.
 14. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.
 15. For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height with required location for equipment served.
 - 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 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide required seismic controls in accordance with Section 26 05 48.
 3. 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.
 4. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 5. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- N. Underground Boxes/Enclosures:
 1. Install enclosure on gravel base, minimum 6 inches deep.
 2. Flush-mount enclosures located in concrete or paved areas.
 3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
 4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
- O. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- P. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- Q. Close unused box openings.
- R. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use. Leave no unused openings in any box. Install close-up plugs as required to seal all openings and removed knockouts.
- S. Provide grounding and bonding in accordance with Section 26 05 26.
- T. Identify boxes in accordance with Section 26 05 53.

3.3 CLEANING

A. Floor Boxes

1. Set floor boxes level and flush with finished floor surface.
 - a. Carpet or Tile: Provide manufacturer's recommended carpet trim ring to transition from adjacent floor surface to floor box lid.
 - b. Concrete, Wood, or Flush Tile: Adjust top lid of box to be level with finished floor level. Provide floor covering to edge of box lid such that adjacent floor surface is flush with lid.

B. Exterior In-Grade Floor Boxes

1. Examine conditions under which outdoor ground boxes are to be installed. Notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
2. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
3. Boxes shall be located in approximate locations as shown on plans. Exact location shall be in well-drained areas, away from inlets and outfalls. Boxes shall not be located in low areas or in areas prone to accumulate standing water. Notify Engineer prior to rough-in and install of any potential water infiltration issues or concerns.
4. Adjacent grade shall be within 1% of level.
5. Provide a pre-installation call and/or site meeting with the manufacturer to discuss proper installation methodologies. Call shall be a minimum of ½ hour and shall cover the following:
 - a. Site specific issues
 - b. Requirements for preparation of box installation

c. Installation requirements

C. 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 26 05 53 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. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 26 05 36 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.
- C. Section 26 05 73 - Power System Studies: Arc flash hazard warning labels.
- D. Section 26 27 26 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- E. Section 27 10 00 - Structured Cabling: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs 2011 (Reaffirmed 2017).
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels 2011 (Reaffirmed 2017).
- C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. 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. 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. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 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 identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - e. Time Switches:
 - 1) Identify load(s) served and associated circuits controlled. Include location.
 - f. Centralized Emergency Lighting Inverters:
 - 1) Identify input and output voltage and phase.
 - 2) Identify power source and circuit number for normal power source. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location.
 - g. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.

- 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
 - 5) Identify type of loads served (e.g. Required Emergency, Required Standby, Optional Standby)
 - h. Electricity Meters:
 - 1) Identify load(s) metered.
 - 2) Unique meter identifier, use identification label.
 2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
 3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
 4. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
 5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 6. Use identification label on inside of door at each fused switch to identify required NEMA fuse class and size.
 7. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
 8. Use field-painted floor markings or floor marking tape to identify required equipment working clearances.
 9. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 10. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.
 11. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
- B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 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 connected grounding electrode system components for grounding electrode conductors.
- C. Identification for Raceways:
 1. Use identification labels, handwritten text using indelible marker, 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.
 2. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
 3. Use underground warning tape to identify underground raceways.
- D. Identification for Cable Tray: Comply with Section 26 05 36.
- E. Identification for Boxes:
 1. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, use only identification labels.
- F. Identification for Devices:
 1. Identification for Communications Devices: Comply with Section 27 10 00.
 2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
 3. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
 4. Use identification label to identify serving branch circuit for all receptacles.
 5. Use identification label 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. Seton Identification Products; [_____]: www.seton.com/#sle.
 2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic or aluminum nameplates suitable for exterior use.
 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
 1. Manufacturers:
 - a. Brother International Corporation: www.brother-usa.com/#sle.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

- C. Format for Equipment Identification:
 - 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend:
 - a. System designation where applicable:
 - 1) Emergency Power System: Identify with text "EMERGENCY".
 - 2) Standby Power System: Identify with text "STANDBY"
 - 3) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
- D. Format for General Information and Operating Instructions:
 - 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 1/4 inch.
 - 5. Color: Black text on white background unless otherwise indicated.
- E. Format for Caution and Warning Messages:
 - 1. Minimum Size: 2 inches by 4 inches.
 - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 1/2 inch.
 - 5. Color: Black text on yellow background unless otherwise indicated.
- F. Format for Receptacle Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Power source and circuit number or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Black text on clear background.
- G. Format for Control Device Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Load controlled or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Black text on clear background.
- H. Format for Fire Alarm Device Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Designation indicated and device zone or address.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

- A. Manufacturers:
 - 1. HellermannTyton; [_____]: www.hellermanntyton.com/#sle.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

- A. Manufacturers:
 - 1. Seton Identification Products; [_____]: www.seton.com/#sle.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- D. Minimum Size:
 - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- E. Legend:
 - 1. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
- F. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 - 1. Seton Identification Products; [_____]: www.seton.com/#sle.
- B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 FLOOR MARKING TAPE

- A. Manufacturers:
 - 1. Seton Identification Products; [_____]: www.seton.com/#sle.

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

2.7 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Seton Identification Products; [_____]: www.seton.com/#sle.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 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. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 73
POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Short-circuit study.
- B. Protective device coordination study.
- C. Arc flash and shock risk assessment.
 - 1. Includes arc flash hazard warning labels.
- D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.
- B. Section 26 24 13 - Switchboards.
- C. Section 26 24 16 - Panelboards.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels 2011 (Reaffirmed 2017).
- B. IEEE 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants 1993 (Reaffirmed 1999).
- C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems 2001, with Errata (2003).
- D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis 1997.
- E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems 2006.
- F. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations 2018, with Errata (2019).
- G. NEMA MG 1 - Motors and Generators 2018.
- H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.
- I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. NFPA 70E - Standard for Electrical Safety in the Workplace 2021.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
 - 2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Submit study reports prior to or concurrent with product submittals.

2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Study preparer's qualifications.
- C. Field testing agency's qualifications.
- D. Study reports, stamped or sealed and signed by study preparer.
- E. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
 1. Include characteristic time-current trip curves for protective devices.
 2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 3. Include documentation of listed series ratings upon request.
 4. Identify modifications made in accordance with studies that:
 - a. Can be made at no additional cost to Owner.
 - b. As submitted will involve a change to the contract sum.
- F. Field quality control reports.
- G. Certification that field adjustable protective devices have been set in accordance with requirements of studies.
- H. Project Record Documents: Revise studies as required to reflect as-built conditions.
 1. Include hard copies with operation and maintenance data submittals.
 2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.6 POWER SYSTEM STUDIES

- A. Scope of Studies:
 1. Perform analysis of new electrical distribution system.
 2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
 3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
- B. General Study Requirements:
 1. Comply with NFPA 70.
 2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
- C. Data Collection:
 1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
 - a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
 - 1) Obtain up-to-date information from Utility Company.
 - 2) Utility Company: Pacific Gas and Electric (PG&E).
 - b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.

- c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
 - d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
 - e. Protective Devices:
 - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
 - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
 - f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
 - g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.
- D. Short-Circuit Study:
- 1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
 - 2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
 - a. Maximum utility fault currents.
 - b. Maximum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 - 3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.
- E. Protective Device Coordination Study:
- 1. Comply with applicable portions of IEEE 242 and IEEE 399.
 - 2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 - 3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.
- F. Arc Flash and Shock Risk Assessment:
- 1. Comply with NFPA 70E.
 - 2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
 - 3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
 - a. Maximum and minimum utility fault currents.
 - b. Maximum and minimum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
- G. Study Reports:
- 1. General Requirements:
 - a. Identify date of study and study preparer.
 - b. Identify study methodology and software product(s) used.
 - c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.

- d. Identify base used for per unit values.
 - e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
 - f. Include conclusions and recommendations.
2. Short-Circuit Study:
 - a. For each scenario, identify at each bus location:
 - 1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
 - 2) Fault point X/R ratio.
 - 3) Associated equipment short circuit current ratings.
 - b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
 3. Protective Device Coordination Study:
 - a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
 - b. For each graph include (where applicable):
 - 1) Partial single-line diagram identifying the portion of the system illustrated.
 - 2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
 - 3) Conductors: Damage curves.
 - 4) Transformers: Inrush points and damage curves.
 - 5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
 - 6) Motors: Full load current, starting curves, and damage curves.
 - 7) Capacitors: Full load current and damage curves.
 - c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
 - 1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
 - 2) Include ground fault pickup and delay.
 - 3) Include fuse ratings.
 - 4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
 - d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
 4. Arc Flash and Shock Risk Assessment:
 - a. For the worst case for each scenario, identify at each bus location:
 - 1) Calculated incident energy and associated working distance.
 - 2) Calculated arc flash boundary.
 - 3) Bolted fault current.
 - 4) Arcing fault current.
 - 5) Clearing time.
 - 6) Arc gap distance.
 - b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

1.7 QUALITY ASSURANCE

- A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in the preparation of studies of

similar type and complexity using specified computer software.

1. Study preparer may be employed by the manufacturer of the electrical distribution equipment.
 2. Study preparer may be employed by field testing agency.
- B. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.
1. Field Supervisor: Certified electrical testing technician; NETA ETT Level III.
- C. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
1. Acceptable Software Products:
 - a. ETAP/Operation Technology, Inc: www.etap.com/#sle.
 - b. Power Analytics Corporation: www.poweranalytics.com/#sle.
 - c. SKM Systems Analysis, Inc: www.skm.com/#sle.

PART 2 PRODUCTS

2.1 ARC FLASH HAZARD WARNING LABELS

- A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
1. Materials: Comply with Section 26 05 53.
 2. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
 - a. Include orange header that reads "WARNING" unless otherwise indicated.
 - b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
 - c. Include the following information:
 - 1) Arc flash boundary.
 - 2) Available incident energy and corresponding working distance.
 - 3) Site-specific PPE (personnel protective equipment) requirements.
 - 4) Nominal system voltage.
 - 5) Limited approach boundary.
 - 6) Restricted approach boundary.
 - 7) Equipment identification.
 - 8) Date calculations were performed.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install arc flash warning labels in accordance with Section 26 05 53.

3.2 FIELD QUALITY CONTROL

- A. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Adjust equipment and protective devices for compliance with studies and recommended settings.
- D. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.
- E. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.3 CLOSEOUT ACTIVITIES

- A. Training: Include as part of the base bid training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.
 - 1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.

END OF SECTION

SECTION 26 09 13
ELECTRICAL POWER MONITORING

PART 1.0 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. The products specified herein are intended to provide a complete sub-metering solution. This solution shall be utilized to measure and monitor owner provided utilities including, but not limited to, electricity, gas, water, and steam. System will also allow for compliance with national and local energy codes and provide equipment needed to meet specific LEED M&V credits.

1.2 SECTION INCLUDES

- A. Electrical sub-metering equipment, data collection systems, and data management software systems including:
 - 1. Standard single point kWh electrical sub-meters
 - 2. Data collection hubs
 - 3. Open protocol data communication network
 - 4. Wireless communication devices
 - 5. Energy monitoring and tenant billing software

1.3 STANDARDS

- A. Provide equipment of this Section in full compliance with the following applicable portions of the latest revisions of the following standards:
 - 1. ANSI C12.1 & C12.20 at 0.5 Accuracy Class
 - 2. UL Certified to IEC/EN/UL/CSA 61010-1 2nd Edition.
 - 3. UL916:
 - a. These requirements cover energy management equipment and associated sensing devices rated 600 volts or less and intended for installation in accordance with the National Electrical Code, NFPA 70.

1.4 SHOP DRAWINGS

- A. Installation and Shop Drawings to include the following:
- B. Manufacturer's literature and specification
- C. Component connection wiring diagrams
- D. Communications system specification

1.5 INSTALLATION, OPERATION, AND MAINTENANCE MANUALS

- A. Submit installation, operation, and maintenance manuals for the electrical sub-metering system data collection system, and data management software.

1.6 TECHNICAL PERFORMANCE

- A. Minimum measured technical performance of each piece of installed equipment shall meet the specifications published by the manufacturer.
- B. Optimize technical performance of all systems to produce the highest achievable technical performance to the satisfaction of consultant and/or client.
- C. Any deficiencies in the system, particularly information communication errors or operational deficiencies, shall be cause for rejection. Rectify any such deficiencies prior to calling for substantial completion review.

1.7 WARRANTY

- A. Manufacturer shall provide a comprehensive warranty for all products.

- B. All electrical sub-meters included in this specification to be free from defects in materials and workmanship from the date of substantial completion for a period of 10 Years.
- C. All data collection system components included in this specification to be free from defects in materials and workmanship from the date of substantial completion for a period of 2 Years.

PART 2.0 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufacturer: Leviton Manufacturing Co. Inc.
- B. Basis of Design: Leviton VerifEye metering system.
- C. Substitutions Permitted:
 - 1. Show all substitutions as an add or deduct from base bid pricing.
 - 2. Provide Manufacturer's reference list.
 - 3. Clearly delineate all propose substitutions as such and submit in writing for approval by the engineer a minimum of 10 working days prior to the bid date
 - 4. Prior to rough-in, provide complete engineered shop drawings, including power wiring, with deviations for the original design highlighted in an alternate color, to the engineer for review and approval.
 - 5. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring.

2.2 METERS AND CURRENT TRANSFORMERS

- A. Standard single point metering devices: Leviton Mini-Meters, Series 1000, and Series 2000
- B. Advanced single point metering devices: Leviton 3300 and 3500 Series
- C. Multipoint metering devices: Leviton 8000 Series.
- D. Leviton solid or split core current transformers with full scale output of 0.1A
- E. Solid Core current transformers available for 100-400A and split core current transformers available from 100-5,000A.
- F. Current transformer secondaries can be extended up to 500 feet.

2.3 SYSTEM DESCRIPTION – SINGLE POINT METERING DEVICES

- A. Provide single point metering devices capable of metering 1PH/2W, 2PH/3W, 3PH/3W, and/or 3PH/4W loads.
- B. Meters must be capable of directly metering North American 120/208/240v and 277/480V.
- C. Metering units must be capable of metering loads between 100A and 5000A. Provide meters specific to each project as indicated on construction drawings.
- D. Metering Units must have the capability of paralleling up to 3 (three) sets of CTs per phase.
- E. Must meet all ISO 9001 standards for quality control where all meters test to a minimum of +/- 0.5% accuracy.
- F. The system shall be as described below:
 - 1. To consist of electronic meters with embedded communications capability, and solid or split-core current transformer technology. The current transformers shall have a full scale output of 0.1A outputs and secondary voltage clamps for safety purposes.
 - 2. Meters to be used for Energy Monitoring and Tenant Billing applications
 - 3. The meters will be capable of remote communication from each metering device.
 - 4. Standard meters shall have isolated pulse output with output ranges from 10Wh to 1kWh.
 - 5. Advanced meters shall transmit data via one of the following communication protocols:
 - a. Standard Ethernet interface

6. Systems to have backup storage power to key components so no data is lost during power outages. Device must be capable of holding 2 years of interval data for a 20 year period. The system shall continue to function after resumption of power.
 7. Failure of the building electrical normal power system shall not result in loss of data and will not require manual restarting of the metering system
- G. The electronic energy monitoring system shall be fully automated microprocessor-based electrical energy measurement system for Measurement and Verification and Tenant Billing purposes. The system shall incorporate complete metering, communications, reporting functions, energy monitoring and threshold limit capabilities.

2.4 SYSTEM MEASUREMENTS – SINGLE POINT METERING DEVICES

- A. Meters to be complete with a Liquid Crystal Display (LCD) to access all energy measurements and phase diagnostics when needed
- B. Standard Meter Energy Parameters:
 1. Real consumption
 2. Resettable kW peak (optional)
- C. Advanced Meter Energy Parameters:
 1. kWh: Real consumption
 2. kW peak: Resettable kW peak
 3. kW: Instantaneous consumption
 4. kVAh: Apparent energy consumption
 5. kVA: Total apparent power
 6. kVARh: Reactive consumption
 7. kVAR: Total reactive power
 8. PF: Power Factor Total
 9. Maximum kW: peak demand with time and date stamp
 10. Hz: Line Frequency
- D. Advanced Meter Phase Diagnostics: Parameters to be displayed for each individual phase of each metered load:
 1. Phase to neutral or phase to phase
 2. Instantaneous amperage for each phase
 3. Instantaneous real energy
 4. Power factor
 5. Instantaneous apparent energy
 6. kVAR Instantaneous reactive energy

2.5 METERS DATA COLLECTION AND COMMUNICATION

- A. Data acquisition server: Leviton Energy Monitoring Hub and Hub Lite
- B. Pulse data collection: Leviton High Density Pulse Module
- C. Wireless data transmission: Leviton Modhopper

2.6 SYSTEM DESCRIPTION METER COMMUNICATIONS AND DATA COLLECTION

- A. The system shall be as described below:
 1. To consist of energy management hubs, pulse modules, wireless communication devices, and software used to transmit, collect, and display data provided by sub-metering equipment used to capture measurements from utilities that include, but are not limited to, electrical, gas, water, and steam.
 2. System to allow all data collected to be connected to IP based applications including Third Party Billing Companies/Software, Enterprise Energy Management Software, Demand Response, and Smart Grid Collection for use in power Measurement and tenant billing.

3. Data collection system shall be all non-proprietary and compatible with industry standard M&V software applications. Open protocols such as Modbus, pulse outputs, analog, resistive inputs, etc. shall be utilized. No manufacture specific protocols between meter and data collectors shall be accepted.

2.7 PRODUCT REQUIREMENTS - DATA AQUISITION SERVER

- A. Provide data acquisition servers that measure and verify data from electrical meters and environmental sensors.
- B. Server shall comply with the following codes and standards:
 1. FCC CFR 47 Part 15, Class A
 2. EN 610000
 3. EN 61326
 4. CE
- C. Server shall be equipped with an ARMg embedded CPU, an ARM7 I/O co-processor, 32MB of onboard RAM, 16MB of NOR flash memory, and a USB expansion port.
- D. Server shall operate under the following conditions:
 1. 32°F to 122°F (0°C to 50°C), 0-90% RH, non-condensing
 2. 41°F to 104°F (5°C to 40°C), 0-90% RH, non-condensing
- E. Server shall have the capability to collect information at intervals from one (1) to sixty (60) minutes.
- F. Server shall timestamp all acquired data and store it in a non-volatile memory.
- G. Server shall use modem and/or Ethernet connections for internet access allowing either static IP (internet protocol) or DHCP (Dynamic Host Control Protocol) addressing.
- H. Server shall communicate with metering data points via wired or wireless connections over the following protocols:
 1. Wired communications:
 - a. Pulse
 - b. Serial Port
 - 1) RS485 Modbus
 - (a) Modbus / RTU
 - (b) Modbus /TCP
 - 2) Modbus devices to be connected via Belden 1120A or equivalent 18g twisted shielded pair.
 2. Wireless Communications:
 - a. Wireless Modbus
- I. Server shall communicate with external devices via wired or wireless connections over the following protocols:
 1. Wired communications:
 - a. Ethernet LAN (Local Area Network) or WAN (Wide Area Network)
 - 1) TCP/IP
 - 2) PPP
 - 3) HTTP/HTML
 - 4) FTP
 - 5) NTP
 - 6) XML
 - 7) SNMP
 - 8) BACnet-Optional Downloaded Module
 2. Wireless Communications:

- a. GSM (Global System for Mobile Communications)
- b. GPRS (General Packet Radio Service)
- c. PSTN (Public Switched Telephone Network)
3. Server shall upload data at scheduled intervals via HTTP or FTP and download data in XML or custom formats.
- J. Server shall generate alarms for data points including SNMP (Simple Network Management Protocol) traps.
- K. Server shall have the following input and output connections:
 1. Input:
 - a. RS485 Modbus serial input capable of supporting 32 external devices. Input to be expandable at owner's option.
 - b. Eight (8) Flex I/O inputs configurable for the following modes:
 - 1) 0-10VDC
 - 2) 4-20mA
 - 3) Resistive
 - 4) Standard KYZ pulse modes for A or C dry contact relay outputs
 - 5) Status
 2. Output:
 - a. Two (2) opto-FET dry contact relays rated at 30VDC and 150mA maximum

2.8 PRODUCT REQUIREMENTS – WIRELESS TRANSCEIVER

- A. Provide OPTIONAL wireless transceiver for collection and distribution of pulse outputs generated by electrical meters and environmental sensors.
- B. Transceiver shall comply with the following codes and standards:
 1. FCC CFR 47 Part 15, Class A emissions standard.
 2. FCC ID to be OUR-9XTREAM
 3. Industry Canada ID to be 4214A-9XTREAM
- C. Transceiver shall be equipped with a 60 MHz ARM7 embedded CPU.
- D. Transceiver firmware to be field upgradable.
- E. Transceiver shall communicate over a self-healing, self-optimizing wireless mesh network. Network shall utilize frequency hopping, spread-spectrum radio transmission and reception over 900MHz band.
- F. Transceiver shall have a range of 3000 feet indoors and 14 miles outdoor line of sight.
- G. Transceiver shall transmit data utilizing a 1W signal strength.
- H. Transceiver shall operate under the following conditions
 1. 32°F to 122°F (0°C to 50°C), 0-90% RH, non-condensing
 2. 1.24 miles (2000m) maximum altitude, degree 2 pollution
- I. Transceiver shall have a pulse counter with pulse data stored in a non-volatile memory.
- J. Transceiver shall have the following input and output connections. Modbus addresses to be adjustable via DIP switches with addresses between 1 and 247.
 1. Input
 - a. Two (2) Pulse inputs with user selectable pulse rates of 10, 50, 100, or 250 Hz.
 - b. Modbus RS485 input
 - 1) Connect a maximum of 32 Modbus devices to transceiver input
 2. Output
 - a. Modbus RS485 output
 - 1) Outputs to be user selectable between 100 Ohms and 2.5 kOhms.

- 2) Two (2) opto-FET dry contact relays rated at 30VDC, 150mA max.

2.9 METER SOFTWARE

- A. Enterprise Energy Management Software: Leviton Energy Manager
- B. Building Management Software; Leviton BMO 2.0
- C. Tennant Billing Software: Leviton BillSuite

2.10 PRODUCT REQUIREMENTS – ENTERPRISE ENERGY MANAGEMENT SOFTWARE

- A. Provide a web hosted software platform which is fully functional without software other than standard web browsers including, but not limited to, Microsoft Internet Explorer and Mozilla Firefox.
- B. Software shall be used for the collection, analysis, and reporting of energy data from sub-metering equipment used to capture measurements from utilities that include, but are not limited to, electrical, gas, water, and steam.
- C. Software shall collect and report data in intervals from one (1) to sixty (60) minutes and illustrate information in real time.
- D. Software shall produce customized reports and display data for all energy management components including cost, kW, kVA, kVAR, and power factor
- E. Software shall include an automatic reporting system and instant alarm notification system.

2.11 PRODUCT REQUIREMENTS – BUILDING MANAGER SOFTWARE

- A. Provide a web hosted software platform which is fully functional without software other than standard web browsers including, but not limited to, Microsoft Internet Explorer and Mozilla Firefox.
- B. Software shall be used for the collection, analysis, and reporting of energy data from sub-metering equipment used to capture measurements from utilities that include, but are not limited to, electrical, gas, water, and steam.
- C. Software shall collect and report data in intervals from one (1) to sixty (60) minutes and illustrate information in real time.
- D. Software shall produce basic charts and graphs for reporting of energy usage trends.
- E. Software shall include an automatic reporting system and instant alarm notification system.
- F. Software shall be provided at no charge to the customer for the first year.

2.12 PRODUCT REQUIREMENTS – TENANT BILLING SOFTWARE

- A. Provide a PC based stand-alone software to be used for the collection, analysis, and reporting of energy data from sub-metering equipment used to capture measurements from utilities that include, but are not limited to, electrical, gas, water, and steam
- B. Software shall be used for automated generation of individual tenant billing invoices utilizing customizable utility rates.

PART 3.0 – EXECUTION

3.1 WIRING AND CONNECTIONS

- A. All wiring must meet and or exceed local electrical code.
- B. Metering points show on submitted drawings only to be connected or installed
- C. Install all wiring in conduit.
- D. Provide a non-dedicated or Ethernet drop for remote meter reading and diagnostics of the system

- E. Perform all necessary system calibration, testing, commissioning, and demonstrations as required
- F. Prepare and submit record drawings and installation, operation and maintenance manuals for the energy management system as required.

3.2 TESTING AND COMMISSIONING

- A. Perform final testing, adjustment, and commissioning of the systems, report results to the Consultant, and include the results in the installation, operation, and maintenance manuals. Provide qualified technicians for testing and commissioning.
- B. Perform sufficient technical and operational tests to ensure the technical performance of the system meets the intent of the Contract Documents. Typical testing to include but not be limited to
 - 1. Verification of meter readings and proper installation of meter equipment
 - 2. Communication system connectivity
 - 3. Meter communication with all software platforms
- C. Provide functional testing including verification that all meters are operating properly.
- D. Test every device and control equipment after programming and submit a signed commissioning certificate and report to the Consultant and to the Client.
- E. Demonstrate the operation of the system to the Owner at a time suitable to them. Such demonstration to include product training on how to program the monitoring system.

3.3 FIELD VERIFICATION, ACCEPTANCE, AND TRAINING

- A. Provide all “AS BUILT” DRAWINGS and data showing each meter, serial number, address, cross reference, load and CT ratio prior to field verification.
- B. Manufacturer’s representative shall verify, adjust and test the system. Verification of the energy monitoring system is to be carried out with the assistance of an electrical contractor at all times. Upon completion, the manufacturer shall issue a “CERTIFICATE OF ACCEPTANCE” to the owner, electrical consultant, contractor and client.
- C. Manufacturer’s representative shall demonstrate operation of the system as follows:
 - 1. Local and remote meter readings
 - 2. Phase diagnostics
 - 3. Provide manual of the installed system
- D. Setup of system software as directed by client.
- E. Provide training and software manual for owner’s staff to review.

3.4 FIELD QUALITY CONTROL

- A. Submit a detailed testing and commissioning procedure to the Consultant and Client for review and approval prior to undertaking this Work. The procedure shall indicate all test equipment required and acceptance criteria.
- B. Upon completion of all testing and commissioning, submit a copy of the test results and certify the system as acceptable for revenue metering purposes.
- C. Undertake the testing and commissioning Work with the manufacturer's factory representative(s).

3.5 INSTRUCTION TO STAFF

- A. Upon completion of the installation, a competent instructor representing the system manufacturer shall provide a lecture to the operating and maintenance staff concerning the intent, use, and operation and maintenance of the system

- B. Staff training shall include a minimum of four hours per shift and training sessions shall be videotaped and turned over to the Owner. Allow for two shifts of staff training.

END OF SECTION

SECTION 26 09 43
DIGITAL LIGHTING CONTROLS
DISTRIBUTED DIGITAL LIGHTING CONTROLS

1.1 GENERAL

A. SECTION INCLUDES

1. Distributed Digital Lighting Control System, including:
 - a. Digital Lighting and Plug Load Controls
 - b. Dimming Controls
 - c. On/Off Controls
 - d. Relay Panels
 - e. Emergency Lighting Control

1.2 RELATED WORK:

- A. See the following specification Section for work related to the work in this section:
1. Integrated Automation Control of HVAC- Integrated Automation, Building integrator shall provide integration of the lighting control system with Building Automation Systems
 2. Lighting
 3. LED Interior Lighting
 4. Lighting Poles and Standards
 5. LED Exterior Lighting
 6. Emergency Lighting
 7. Raceways for Communications Systems

1.3 STANDARDS AND CODES:

- A. Work and materials shall be in compliance and according to the requirements of the latest revision of the following Standards and Codes:
1. CEC - California Electrical Code
 2. NFPA 70 - National Electrical Code; National Fire Protection Association.
 3. NEMA - National Electrical Manufacturers Association
 4. FCC emission standards
 5. UL - Underwriters Laboratories, Inc. Listings
 6. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products Installed in Air-Handling Spaces.
 7. UL 20 - General Use Switches, Plug Load Controls
 8. UL 924 - Standard for Emergency Lighting and Power Equipment

1.4 DESIGN AND PERFORMANCE REQUIREMENTS:

- A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters.
- B. System shall conform to requirements of CEC [NFPA 70].
- C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.
- D. System shall be listed under UL sections 916 and/or 508.

1.5 SUBMITTALS:

- A. As specified in Division 1 and Section 26 05 00.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Catalog sheets and specifications.

2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 3. Storage and handling requirements and recommendations.
 4. Installation instructions.
- C. Shop Drawings: Wiring diagrams a for the various components of the System specified including:
1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
 2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
 3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
 4. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.
- D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- E. Closeout Submittals:
1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
 2. Operation and Maintenance Manual:
 - a. Include approved Shop Drawings and Product Data.
 - b. Include Sequence of Operation, identifying operation for each room or space.
 - c. Include manufacturer's maintenance information.
 - d. Operation and Maintenance Data: Include detailed information on device programming and setup.
 - e. Include startup and test reports.
- 1.6 QUALITY ASSURANCE:
- A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.
 - B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.
 - C. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.
- 1.7 WARRANTY:
- A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.
- 1.8 EXTRA MATERIALS:
- A. Deliver extra sets of items for Owner's use in maintenance as follows:
 1. Occupancy Sensors: (1) of each type installed
 2. Switches: (1) of each type installed
 3. Room Controllers: (1) of each type installed
 4. Emergency Lighting Control Units: (1) of each type installed

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Wattstopper or approved equal.

2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM:

- A. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.
1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
 3. Digital Plug Load Controllers: Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.
 4. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 5. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
 6. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
 7. Configuration Tools: Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
 8. Digital Lighting Management (DLM) segment network: Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.
 9. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
 10. Segment Manager: BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
 11. Programming and Configuration Software: Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
 12. Digital Lighting Management Relay Panel and Zone Controller: Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.
 13. Emergency Lighting Control Unit (ELCU): Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

2.3 LOCAL NETWORK LMRJ-SERIES: DLM LOCAL NETWORK IS A FREE TOPOLOGY LIGHTING CONTROL PHYSICAL CONNECTION AND COMMUNICATION PROTOCOL DESIGNED TO CONTROL A SMALL AREA OF A BUILDING.

- A. Features of the DLM local network include:

1. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 2. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
 3. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
- B. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
- C. If manufacturer's pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.
- 2.4 DIGITAL LOAD CONTROLLERS (ROOM, PLUG LOAD, AND FIXTURE CONTROLLERS)
- A. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting and plug load control requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n' Go applications. Control units include the following features
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
 3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
 4. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
 5. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
 6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
 7. Each load be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off)
 - b. Manual-on/Auto-off (Follow off only)
 8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.

9. BACnet object information shall be available for the following objects:
 - a. Load status
 - b. Schedule state, normal or after-hours
 - c. Demand Response enable and disable
 - d. Room occupancy status
 - e. Total room lighting and plug loads watts
 - f. Electrical current
 - g. Total watts per controller
 - h. Total room watts/sq ft.
 - i. Force on/off all loads
 10. UL 2043 plenum rated
 11. Manual override and LED indication for each load
 12. Zero cross circuitry for each load
 13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
 14. Dimming Room Controllers shall share the following features:
 15. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
 16. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 17. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100 percent
 - b. Set high and low trim for each load
 - c. Initiate lamp burn in for each load of either 0, 12 or 100 hours
 18. Override button for each load provides the following functions:
 - a. Press and release for on/off control
 - b. Press and hold for dimming control
 19. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 20. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
 21. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
 22. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
- B. Plug Load Controllers shall include:
1. 120 VAC, 60 Hz rated for 20A total load. Controller carries application-specific UL 20 rating for receptacle control.
 2. One relay configuration with additional connection for unswitched load
 3. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
 4. Factory default operation is Auto-on/Auto-off, based on occupancy
 5. Real time current monitoring of both switched and un-switched load (LMPL-201 only)

6. Switching power supply
 - a. Simple 150mA - Only 4 100 series devices on a Cat 5e local network (LMPL-101)
 - b. Smart 250mA (LMPL-201)
7. RJ-45 DLM local network ports
 - a. Three RJ-45 ports (LMPL-101)
 - b. Four RJ-45 ports (LMPL-201)
8. WattStopper product numbers:
 - a. Plug Load Controllers: LMPL-101, LMPL-201.
 - b. Wireless Transceiver and Receptacles: WRC-TX-LM, WRC-15-1/2, WRC-20-1/2

2.5 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

- A. Wall or ceiling mounted (to suit installation) passive infrared, ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square footage coverage requirements for each area controlled, utilizing Room Controller modules and accessories which suits the lighting and electrical system parameters.
- B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and LCD entry for the following variables:
 - a. Sensitivity 0-100% in 10% increments
 - b. Time Delay – Fixed (1-30 minutes in 1 minute increments), and automatic
 - c. Test mode – Five second time delay
 - d. PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including auto/manual ON, blink warning, and daylight enable/disable.
 2. One or two RJ-45 digital connections for DLM local network.
 3. Two-way infrared communications port to allow remote programming through hand held commissioning tool.
 4. Device Status LED's including:
 - a. PIR Detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 6. Manual override of controlled loads.
- C. Units will provide for digital calibration and commissioning and will not have any dip switches or potentiometers for field settings
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required
- E. Manufacturer: The Watt Stopper LMPX, LMDX, LMPC, LMUC, LMDC or approved equal.

2.6 SINGLE / DUAL RELAY WALL SWITCH VACANCY SENSORS

- A. Passive infrared sensing technology- Type PW: Manual ON, Automatic OFF Wall switch type passive infrared occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper PW-100, PW-200 PW-103, PW-203 or approved equal.

- B. Ultrasonic sensing technology- Type UW: Manual ON, Automatic OFF Wall switch type ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper UW-100, UW-200 or approved equal.
- C. Dual-tech (utilizing both passive infrared and ultrasonic) sensing technology- Type DW: Manual ON, Automatic OFF Wall switch type dual technology, passive Infrared and ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper DW-100, DW-200, DW-103, DW-203 or approved equal.

2.7 DIGITAL WALL SWITCHES:

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
 - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Configuration LED on each switch that blinks to indicate data transmission.
 - 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 - 5. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
 - 6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
 - 1. Button state
 - 2. Switch lock control
 - 3. Switch lock status
- C. Two RJ-45 ports for connection to DLM local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
 - 1. Individual button function may be configured to Toggle, On only or Off only.
 - 2. Individual scenes may be locked to prevent unauthorized change.
 - 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.

4. Ramp rate may be adjusted for each dimmer switch.
5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
6. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.8 DIGITAL DAYLIGHT SENSORS:

- A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
 1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
 2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
 3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone
- B. Digital daylighting sensors shall include the following features:
 1. Sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
 2. Sensor light level range shall be from 1-6,553 foot-candles (fc).
 3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
 5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
 6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
 7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
 8. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
 9. Configuration LED status light on device that blinks to indicate data transmission.
 10. Status LED indicates test mode, override mode and load binding.
 11. Recessed switch on device to turn controlled load(s) ON and OFF.
 12. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - a. Light level
 - b. Day and night setpoints
 - c. Off time delay
 - d. On and off setpoints

- e. Up to three zone setpoints
- f. Operating mode - on/off, bi-level, tri-level or dimming
- 13. One RJ-45 port for connection to DLM local network.
- 14. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.
- 15. Any load or group of loads in the room can be assigned to a daylighting zone
- 16. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
- 17. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

2.9 HANDHELD CONFIGURATION TOOLS:

- A. Provide a wireless configuration tool to facilitate customization of DLM local networks using two-way infrared communications, and/or PC software that connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include but not be limited to:
 - 1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 - 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 - 3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.
 - 4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
 - 5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
 - 6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
 - 7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
 - 8. Verify status of building level network devices.
- C. WattStopper Product Numbers: Handheld LMCT-100

2.10 DLM SEGMENT NETWORK

- A. Provide a segment network using linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
 - 1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
 - 2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
 - 3. Segment network utilizes 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a

characteristic impedance of 120 Ohms.

4. Network wire jacket is available in high visibility green, white, or black.
5. Substitution of manufacturer-supplied cable is not permitted and may void the warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
6. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
7. Segment networks shall be capable of connecting to any of the following: BACnet-compliant BAS (provided by others) directly via MS/TP, or BACnet/IP via an NB-ROUTER or LMSM Unit. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable

B. WattStopper Product Number: LM-MSTP, LM-MSTP-W, LM-MSTP-B, LM-MSTP-DB

2.11 NETWORK BRIDGE:

A. Network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.

1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
2. Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
3. Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller
 - h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - i. Activate a preset scene for the room
 - j. Read/write daylight sensor fade time and day and night setpoints
 - k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
 - l. Set daylight sensor operating mode
 - m. Read/write wall switch lock status
 - n. Read watts per square foot for the entire controlled room
 - o. Write maximum light level per load for demand response mode

- p. Read/write activation of demand response mode for the room
 - q. Activate/restore demand response mode for the room
4. WattStopper product numbers: LMBC-300

2.12 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER:

- A. Hardware: Provide LMCP lighting control panels in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:
- 1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
 - 2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
 - 3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. Panel interiors shall include the following features:
 - a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
 - b. Individual terminal block, override pushbutton, and LED status light for each relay.
 - c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
 - d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
 - e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
 - f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
 - g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
 - h. Relay group status shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
 - 4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
 - a. Electrical:
 - b. 30 amp ballast at 277V
 - c. 20 amp ballast at 347V
 - d. 20amp tungsten at 120V
 - e. 30 amp resistive at 347V
 - f. HP motor at 120V
 - g. 14,000 amp short circuit current rating (SCCR) at 347V
 - h. Relays shall be specifically UL 20 listed for control of plug-loads

- i. Mechanical:
 - j. Replaceable, 1/2 inch KO mounting with removable Class 2 wire harness.
 - k. Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - l. Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
 - m. Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
 6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
 7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
 8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
 - a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 networked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
 - b. Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
 - c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
 - d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - e. Scheduled ON / OFF
 - f. Manual ON / Scheduled OFF
 - g. Astro ON / OFF (or Photo ON / OFF)
 - h. Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
 - i. User interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
 - j. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
 - k. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
 9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.
 10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet

protocol.

- a. Panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
 - b. Panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
 - c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
 - d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.
 - e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
 - f. Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
 - g. Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
 - h. Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
 - i. Binary input objects in the instance range of 1 - 64 (one per relay) for reading true on/off state of the relays.
 - j. Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
 - k. Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
 - l. BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>)
 - m. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
 - n. Lockout of all digital switch buttons connected to a given panel shall be commandable via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
- a. Use the same intelligence board as the LMCP relay panel.
 - b. Shall not include relay driver boards or relays.

- c. Have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
 - d. Tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
 - e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n' Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50 percent output when any digital occupancy sensor detects motion.
 13. WattStopper Product Number: Relay Panels: LMCP8, LMCP24 or LMCP48, Zone Controller: LMZC-301.
- B. User Interface: Each lighting control panel system shall be supplied with at least one handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. User interface shall have the following panel-specific functions as a minimum:
1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
 3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
 4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
 5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
 6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
 7. WattStopper Product Number: LMCT-100
- 2.13 SEGMENT MANAGER:
- A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).
 - B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the Drawings.

- C. Operational features of the Segment Manager shall include the following:
1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.
 3. Log in security capable of restricting some users to view-only or other limited operations.
 4. Segment Manager shall provide two main sets of interface screens - those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system, and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
 - a. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
 - b. Allow information for all discovered DLM devices to be imported into the Segment Manager via a single XML based site file from the WattStopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager
 - c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
 - d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
 - e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.
 5. Capabilities using the Segment Manager's Dashboard Screens shall include:
 - a. A dynamic "tile" based interface that allows easy viewing of each individual room's lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers such as LMRC-21x). Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles use three color coded energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. Tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the

information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.

- b. Ability to set up schedules for DLM local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.
 - c. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager's memory (typically two to three days' data).
6. If shown on the Drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.
7. Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.
- D. Segment Manager shall support multiple DLM rooms as follows:
1. Support up to 120 network bridges and 900 digital in-room devices (LMSM-3E).
 2. Support up to 300 network bridges and 2,200 digital in room devices, connected via network routers and switches (LMSM-6E).
- E. WattStopper Product Numbers: LMSM-3E, LMSM-6E, LM-SUPERVISOR, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.14 PROGRAMMING, CONFIGURATION, AND DOCUMENTATION SOFTWARE:

- A. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.
1. Additional parameters exposed through this method include but are not limited to:
 - a. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
 - b. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
 - c. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
 - d. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
 - e. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
 - f. Load control polarity reversal so that on events turn loads off and vice versa.

- g. Per-load DR (demand response) shed level in units of percent.
 - h. Load output pulse mode in increments of 1 second.
 - i. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.
2. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
- a. Device list report: All devices in a project listed by type.
 - b. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 - c. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
 - d. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
 - e. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
 - f. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100 percent, 2 = all loads 75 percent, 3 = all loads 50 percent, 4 = all loads 25 percent, 5-16 = same as scene 1).
 - g. Occupancy sensor report: Basic settings including time delay and sensitivities for all occupancy sensors.
3. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
- a. Set, copy/paste an entire project site of sensor time delays.
 - b. Set, copy/paste an entire project site of sensor sensitivity settings.
 - c. Search based on room name and text labels.
 - d. Filter by product type (i.e. LMRC-212) to allow parameter set by product.
 - e. Filter by parameter value to search for product with specific configurations.
4. Network-wide firmware upgrading remotely via the BACnet/IP network.
- a. Mass firmware update of entire rooms.
 - b. Mass firmware update of specifically selected rooms or areas.
 - c. Mass firmware upgrade of specific products

B. WattStopper Product Number: LMCS-100, LMCI-100

2.15 EMERGENCY LIGHTING CONTROL DEVICES:

A. Emergency Lighting Control Unit - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

- 1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
- 2. Push to test button
- 3. Auxiliary contact for remote test or fire alarm system interface

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

PART 3 EXECUTION

3.1 PRE-INSTALLATION MEETINGS:

A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Architect, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.

- B. Review installation procedures and coordination required with related Work and the following:
 - 1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
 - 2. Review the specifications for low voltage control wiring and termination.
 - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - 4. Discuss requirements for integration with other trades
- C. Inspect and make notes of job conditions prior to installation:
 - 1. Record minutes of the conference and provide copies to all parties present.
 - 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 - 3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Architect.

3.2 DELIVERY, STORAGE, AND HANDLING:

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

3.3 PROJECT CONDITIONS:

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.

3.4 PREPARATION:

- A. Do not begin installation until measurements have been verified and work areas have been properly prepared.
- B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that required pre-installation meeting has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

3.5 INSTALLATION:

- A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.
- B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
 - 1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
 - 2. Install all room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty.
 - 3. Low voltage wiring topology must comply with manufacturer's specifications.
 - 4. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.
- C. All line voltage connections shall be tagged to indicate circuit and switched legs.

- D. Test all devices to ensure proper communication.
- E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.
- F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- G. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.
- H. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.
- I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.
- J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.
- K. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.

3.6 FIELD QUALITY CONTROL:

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.
- B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
 - 1. Verify Class I and II wiring connections are terminated properly by validating system performance.
 - 2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
 - 3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
 - 4. Verify that the control of each space complies with the Sequence of Operation.
 - 5. Correct any system issues and retest..
- C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
 - 1. Date of test or inspection.
 - 2. Loads per space, or Fixture Address identification.
 - 3. Quantity and Type of each device installed
 - 4. Reports providing each device's settings.

3.7 DEMONSTRATION AND TRAINING:

- A. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instruction includes:
 - 1. Confirmation of entire system operation and communication to each device.
 - 2. Confirmation of operation of individual relays, switches, and sensors.
 - 3. Confirmation of system Programming, photocell settings, override settings, etc.

4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

3.8 PRODUCT SUPPORT AND SERVICE:

- A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

END OF SECTION

SECTION 26 21 00
LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical service requirements.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 24 13 - Switchboards: Service entrance equipment.

1.3 DEFINITIONS

- A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.4 REFERENCE STANDARDS

- A. IEEE C2 - National Electrical Safety Code 2017.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.
- B. Coordination:
 - 1. Verify the following with Utility Company representative:
 - a. Utility Company requirements, including division of responsibility.
 - b. Exact location and details of utility point of connection.
 - c. Utility easement requirements.
 - d. Utility Company charges associated with providing service.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
 - 3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Coordinate the work with other installers to provide communication lines required for Utility Company meters.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.
- D. Utility Company charges associated with providing permanent service to be paid by Owner.
- E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.
- F. Scheduling:

1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.6 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.
- B. Shop Drawings: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.
 1. Obtain Utility company approval of shop drawings prior to submittal.
- C. Drawings prepared by Utility Company.
- D. Project Record Documents: Record actual locations of equipment and installed service routing.

1.7 QUALITY ASSURANCE

- A. Comply with the following:
 1. IEEE C2 (National Electrical Safety Code).
 2. NFPA 70 (National Electrical Code).
 3. The requirements of the Utility Company.
 4. The requirements of the local authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). 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 products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 ELECTRICAL SERVICE REQUIREMENTS

- A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.
- B. Electrical Service Characteristics: As indicated on drawings.
- C. Utility Company: Pacific Gas and Electric (PG&E).
- D. Division of Responsibility:
 1. Pad-Mounted Utility Transformers:
 - a. Transformer Vaults and Pads: Furnished and installed by Contractor per Utility Company requirements.
 - b. Transformers: Furnished and installed by Utility Company.
 - c. Transformer Grounding Provisions: Furnished and installed by Contractor per Utility Company requirements.
 - d. Transformer Protective Bollards: Furnished and installed by Contractor per Utility Company requirements.
 - e. Primary:
 - 1) Trenching and Backfilling: Provided by Contractor.
 - 2) Conduits: Furnished and installed by Contractor.
 - 3) Conductors: Furnished and installed by Utility Company.

- f. Secondary:
 - 1) Trenching and Backfilling: Provided by Contractor.
 - 2) Conduits: Furnished and installed by Contractor.
 - 3) Conductors: Furnished and installed by Contractor (Service Point at transformer).
- 2. Terminations at Service Point: Provided by Utility Company.
- 3. Metering Provisions:
 - a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.
 - b. Metering Transformer Cabinets: Furnished and installed by Contractor per Utility Company requirements.
 - c. Metering Compartments in Service Entrance Equipment: Furnished and installed by Contractor per Utility Company requirements.
 - d. Metering Transformers: Furnished and installed by Utility Company.
 - e. Conduits Between Metering Transformers and Meters: Furnished and installed by Contractor per Utility Company requirements.
 - f. Wiring Between Metering Transformers and Meters: Furnished and installed by Utility Company.
 - g. Communications Conduits for Meters: Furnished and installed by Contractor per Utility Company requirements.
- E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions and Utility Company requirements.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances and required maintenance access.
- D. Construct cast-in-place concrete pads for utility equipment in accordance with the Utility Company requirements
- E. Provide required protective bollards in accordance with Utility Company requirements.
- F. Provide required support and attachment components in accordance with Section 26 05 29.
- G. Provide grounding and bonding for service entrance equipment in accordance with Section 26 05 26.
- H. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 05 53.

3.4 PROTECTION

- A. Protect installed equipment from subsequent construction operations.

END OF SECTION

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SECTION 26 24 13
SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.
- B. Overcurrent protective devices for switchboards.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
 - 1. Includes requirements for the seismic qualification of equipment specified in this section.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- G. Section 26 21 00 - Low-Voltage Electrical Service Entrance.
 - 1. Includes Utility Company contact information.
- H. Section 26 43 00 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e (Amended 2017).
- B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- D. NECA 400 - Standard for Installing and Maintaining Switchboards 2007.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- F. NEMA PB 2 - Deadfront Distribution Switchboards 2011.
- G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less 2013.
- H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.
- I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.
- K. UL 869A - Reference Standard for Service Equipment Current Edition, Including All Revisions.
- L. UL 891 - Switchboards Current Edition, Including All Revisions.
- M. UL 1053 - Ground-Fault Sensing and Relaying Equipment 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 from Contract Documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:

1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
3. See Section 26 21 00 for Utility Company contact information and additional requirements.
4. Obtain Utility Company approval of switchboard prior to fabrication.
5. Preinstallation Meeting: Convene one week prior to commencing work of this section to review requirements with Utility Company representative.
6. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
 2. Include wiring diagrams showing all factory and field connections.
 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 4. Identify mounting conditions required for equipment seismic qualification.
- D. Manufacturer's equipment seismic qualification certification.
- E. Service Entrance Switchboards: Include documentation of Utility Company approval of switchboard.
- F. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 2 as production (routine) tests.
- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- H. Field Quality Control Test Reports.
 - I. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.
 - J. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
 - K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Enclosure Keys: Two of each different key.
 - 3. Electronic Trip Circuit Breakers: Provide one portable test set.
- 1.6 QUALITY ASSURANCE
- A. Conform to requirements of NFPA 70.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.
 - B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are 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 switchboard 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. Switchboards - Basis of Design: Schneider Electric; Square D Products.
- B. Switchboards - Other Acceptable Manufacturers:
 - 1. Eaton Corporation; [_____]: www.eaton.com/#sle.
 - 2. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- D. Source Limitations: Furnish switchboards 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 SWITCHBOARDS

- A. Provide switchboards 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 switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

- D. Front-Connected Switchboards:
 - 1. Main Device(s): Individually-mounted.
 - 2. Feeder Devices: Panel/group-mounted.
 - 3. Arrangement: Front accessible only (not rear accessible), rear aligned.
 - 4. Gutter Access: Bolted covers.
- E. Service Entrance Switchboards:
 - 1. Listed and labeled as suitable for use as service equipment according to UL 869A.
 - 2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
 - 3. Comply with Utility Company requirements for electrical service.
 - 4. Utility Metering Provisions: Provide separate barriered compartment complying with Utility Company requirements where indicated or where required by Utility Company. Include hinged sealable door and provisions for Utility Company current transformers (CTs), potential transformers (PTs), or potential taps as required.
 - 5. See Section 26 21 00 for additional requirements.
- F. Seismic Qualification: Provide switchboards and associated components suitable for application under the seismic design criteria specified in Section 26 05 48 where required. Include certification of compliance with submittals.
- G. Service Conditions:
 - 1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude: Less than 6,600 feet.
 - b. Ambient Temperature:
 - 1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.
 - 2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
- H. Short Circuit Current Rating:
 - 1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
 - 2. Listed series ratings are acceptable only where specifically indicated.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- I. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.
- J. Bussing: Sized in accordance with UL 891 temperature rise requirements.
 - 1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
 - 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 switchboard, 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.
- K. 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.
 - L. Enclosures:
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
 - b. Outdoor Locations: Type 3R.
 2. Finish: Manufacturer's standard unless otherwise indicated.
 3. Enclosure Space Heaters:
 - a. Provide in each switchboard section 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 {CH#113014}.
 4. Outdoor Enclosures:
 - a. Enclosure Type: Non-walk-in type unless otherwise indicated.
 - b. Color: Manufacturer's standard.
 - c. Access Doors: Lockable, with all locks keyed alike.
 - M. Future Provisions:
 1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
 2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.
 3. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.
 - N. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list switchboards as a complete assembly including surge protective device.
 - O. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 - P. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.
 - Q. 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 OVERCURRENT PROTECTIVE DEVICES
- A. Circuit Breakers:

1. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
2. Molded Case Circuit Breakers:
 - a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 1) Provide thermal magnetic circuit breakers {CH#113043}.
 - 2) Provide electronic trip circuit breakers {CH#113044}.
 - b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1) Provide the following field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.

2.4 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard 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.
 5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive switchboards.
- 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 switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

- C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.
- D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install switchboards plumb and level.
- G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Install all field-installed devices, components, and accessories.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.
- L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- M. Provide filler plates to cover unused spaces in switchboards.
- N. Identify switchboards in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.
- 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 switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.
- 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. Molded Case and Insulated 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.
- G. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
 - 1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.
- H. 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.
- I. Correct deficiencies and replace damaged or defective switchboards or associated components.
- J. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

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

3.5 CLEANING

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

3.6 CLOSEOUT ACTIVITIES

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

3.7 PROTECTION

- A. Protect installed switchboards from subsequent construction operations.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- F. Section 26 22 00 - Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.
- G. Section 26 27 13 - Electricity Metering: For interface with equipment specified in this section.
- H. Section 26 43 00 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e (Amended 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 - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.
- 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.
- M. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.
- N. UL 1699 - Arc-Fault Circuit-Interrupters 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. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- B. 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. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
 2. Include wiring diagrams showing all factory and field connections.
 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 4. Include documentation of listed series ratings upon request.
 5. Identify mounting conditions required for equipment seismic qualification.
- C. Manufacturer's equipment seismic qualification certification.
- 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. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- 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 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 and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D Products; [_____]: www.schneider-electric.us/#sle.

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. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
- 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.
 - b. Outdoor Locations: Type 3R.
 - 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.

- c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
 - 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. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list and label panelboards as a complete assembly including surge protective device.
- K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- L. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.
- M. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Feed-through lugs.
 - 2. Sub-feed lugs.

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: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Copper.
 - 2. Ground Bus Material: Copper.
- 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 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit 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: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.

- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Copper.
 - 3. Ground Bus Material: Copper.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as 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.

2.5 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.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Copper, suitable for terminating copper conductors only.
 - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - b. Provide interchangeable trip units for circuit breaker frame sizes 600 amperes and larger.
 - 5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 - 6. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
 - c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
 - d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
 - e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
 - 7. Do not use tandem circuit breakers.
 - 8. Do not use handle ties in lieu of multi-pole circuit breakers.
 - 9. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

10. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.
 - c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
 - d. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
 - e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.6 SOURCE QUALITY CONTROL

- A. 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 26 05 29.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- J. Provide grounding and bonding in accordance with Section 26 05 26.
- K. Install all field-installed branch devices, components, and accessories.
- L. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- M. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- N. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.
- O. Provide filler plates to cover unused spaces in panelboards.

- P. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Fire detection and alarm circuits.
- Q. Identify panelboards in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - 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 225 amperes. Tests listed as optional are not required.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Test GFCI circuit breakers to verify proper operation.
- F. Test AFCI circuit breakers to verify proper operation.
- G. Test shunt trips to verify proper operation.
- H. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.
- I. 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 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 26 05 33.16 - Boxes for Electrical Systems.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 05 83 - Wiring Connections: Cords and plugs for equipment.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for 2014h, with Amendments (2017).
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification) 2014g, with Amendment (2017).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2020).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2016.
- G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 20 - General-Use Snap Switches Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles Current Edition, Including All Revisions.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.
- L. UL 1310 - Class 2 Power Units 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. Switches shall be located on the strike side of the door, unless otherwise noted, and shall not be obstructed by the door when it is in the open position.
 - 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. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- B. 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.
- C. Operation and Maintenance Data:
 1. GFCI Receptacles: Include information on status indicators.
- D. Project Record Documents: Record actual installed locations of wiring devices.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
 2. Extra Wall Plates: One of each style, size, and finish.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. 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. 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, kindergarten classrooms, and daycare facilities.
- E. Provide GFCI protection for receptacles installed within 6 feet of sinks.
- F. Provide GFCI protection for receptacles installed in kitchens.
- G. Provide GFCI protection for receptacles serving electric drinking fountains.
- H. Unless noted otherwise, do not use combination switch/receptacle devices.

2.2 WIRING DEVICE FINISHES

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

2.3 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell Incorporated; [____]: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc; [____]: www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; [____]: www.legrand.us/#sle.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.4 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated; [____]: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc; [____]: www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; [____]: www.legrand.us/#sle.
- B. 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: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 - 2. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.
 - 3. Weather Resistant Convenience Receptacles: Industrial 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.
 - 4. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; 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: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 - 3. Combination AFCI and GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as a combination

- GFCI/AFCI protective device and complying with UL 498, UL 943, and UL 1699A.
4. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 5. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
- E. USB Charging Devices:
1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
 - a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
 - b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.
 2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (One Type-A and One Type-C) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
 3. USB Charging Noncombination Devices: Four-port (Two Type-A and Two Type-C); rectangular decorator style.

2.5 WALL PLATES

- A. Manufacturers:
1. Hubbell Incorporated; [____]: www.hubbell-wiring.com/#sle.
 2. Leviton Manufacturing Company, Inc; [____]: www.leviton.com/#sle.
 3. Pass & Seymour, a brand of Legrand North America, Inc; [____]: www.legrand.us/#sle.
- B. Wall 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. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- E. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- F. Premarked Wall Plates: Factory labeled as indicated; hot stamped for nylon wall plates and engraved for metal wall plates.
- G. Weatherproof Covers for Wet or Damp Locations: Gasketed, cast aluminum, 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 26 05 33.16 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 wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 - 4. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- M. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- N. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- O. Identify wiring devices in accordance with Section 26 05 53.

3.4 FIELD QUALITY CONTROL

- A. Inspect each wiring device for damage and defects.

- B. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- C. Test each receptacle to verify operation and proper polarity.
- D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- E. 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

SECTION 26 28 13
FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 05 73 - Power System Studies: Additional criteria for the selection of protective devices specified in this section.
- C. Section 26 28 16.16 - Enclosed Switches: Fusible switches.

1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses 2012.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements Current Edition, Including All Revisions.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses Current Edition, Including All Revisions.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
 - 1. Spare Fuse Cabinet: Include dimensions.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fuses: One set(s) of three for each type and size installed.
 - 2. Fuse Pullers: One set(s) compatible with each type and size installed.
 - 3. Spare Fuse Cabinet Keys: Two.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having

jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Busmann, a division of Eaton Corporation; [_____]: www.cooperindustries.com/#sle.

2.2 APPLICATIONS

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

2.3 FUSES

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

2.4 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where indicated.
- D. Identify spare fuse cabinet in accordance with Section 26 05 53.

END OF SECTION

SECTION 26 28 16.16
ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.
- F. Section 26 28 13 - Fuses.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum) 2013.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.
- E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- H. UL 98 - Enclosed and Dead-Front Switches Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Identify mounting conditions required for equipment seismic qualification.
- C. Manufacturer's equipment seismic qualification certification.
- D. Field Quality Control Test 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, installation, and starting of product.
- F. Project Record Documents: Record actual locations of enclosed switches.
- 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 26 28 13 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. 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. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D Products; [_____]: www.schneider-electric.us/#sle.
- B. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Seismic Qualification: Provide enclosed safety switches suitable for application under the seismic design criteria specified in Section 26 05 48 where required. Include certification of compliance with submittals.
- D. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.
2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- E. Horsepower Rating: Suitable for connected load.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Short Circuit Current Rating:
 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
 2. Minimum Ratings:
 - a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.
 - b. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
 - c. Double Throw Switches Protected by Class R, Class J, or Class T Fuses: 100,000 rms symmetrical amperes.
- H. Provide with switch blade contact position that is visible when the cover is open.
- I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- J. Conductor Terminations: Suitable for use with the conductors to be installed.
- K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- M. 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.
 - b. Outdoor Locations: Type 3R.
- N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- O. Heavy Duty Switches:
 1. Comply with NEMA KS 1.
 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
 - a. Provide means for locking handle in the ON position where required.
- P. Provide the following features and accessories where indicated or where required to complete installation:
 1. Hubs: As required for environment type; sized to accept conduits to be installed.
 2. Integral fuse pullers.
 3. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Provide required seismic controls in accordance with Section 26 05 48.
- F. Install enclosed switches plumb.
- G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Identify enclosed switches in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- C. Correct deficiencies and replace damaged or defective enclosed safety switches 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 switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 51 00
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 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- D. Section 26 09 23 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- E. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.

1.3 REFERENCE STANDARDS

- A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code) 2013 (Corrigendum 2019).
- B. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information 2019.
- C. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products 2019.
- D. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources 2021.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- F. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems 2006.
- G. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems 2006.
- H. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices 2020.
- I. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012 (Reaffirmed 2018).
- J. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 924 - Emergency Lighting and Power Equipment Current Edition, Including All Revisions.
- M. UL 1598 - Luminaires Current Edition, Including All Revisions.
- N. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

1.4 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. 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.
- 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, 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.
- C. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.
- 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.
- G. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. 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. Provide five year manufacturer warranty for LED luminaires, including drivers.
- B. Provide five year pro-rata warranty for batteries for emergency lighting units.
- C. Provide ten 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.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- H. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- I. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.
 - 1. LED Tape - General Requirements:
 - a. Listed.
 - b. Designed for field cutting in accordance with listing.
 - c. Wet Location Applications: IEC 60529, IP 68 (waterproof) rated.
- J. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.
- K. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.3 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. Self-Powered Exit Signs:
 - a. 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.
 - b. Battery: Sealed, maintenance-free, nickel cadmium unless otherwise indicated.
 - c. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
 - d. Provide low-voltage disconnect to prevent battery damage from deep discharge.
 - e. 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.

2.4 BALLASTS AND DRIVERS

- A. Ballasts/Drivers - General Requirements:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
 - 3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.
- B. Dimmable LED Drivers:
 - 1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
 - 2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.5 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.
- D. Fire-Rated Luminaire Enclosures:
 - 1. Manufacturers:
 - a. Fire Rated Product Specialties Corp; [_____]: www.frpsonline.com/#sle.
 - b. Specialty Products & Insulation (SPI); SafeLite: www.spi-co.com/#sle.
 - 2. Provide as required to preserve fire resistance rating of building elements.

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 26 05 33.16 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 26 05 29.
- F. Provide required seismic controls in accordance with Section 26 05 48.
- G. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- H. 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 gage, 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.
- I. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- J. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
 - 4. Install canopies tight to mounting surface.
 - 5. Unless otherwise indicated, support pendants from swivel hangers.

- K. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- L. Install accessories furnished with each luminaire.
- M. Bond products and metal accessories to branch circuit equipment grounding conductor.
- N. Exit Signs:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

3.4 FIELD QUALITY CONTROL

- A. Inspect each product for damage and defects.
- B. Operate each luminaire after installation and connection to verify proper operation.
- C. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
- D. 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) 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. 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

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior luminaires.
- B. Ballasts.
- C. Poles and accessories.
- D. Luminaire accessories.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- E. Section 26 09 23 - Lighting Control Devices: Automatic controls for lighting including outdoor motion sensors, time switches, and outdoor photo controls.
- F. Section 26 27 26 - Wiring Devices: Receptacles for installation in poles.
- G. Section 26 28 13 - Fuses.

1.3 REFERENCE STANDARDS

- A. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing 2017.
- B. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code) 2013 (Corrigendum 2019).
- C. IEEE C2 - National Electrical Safety Code 2017.
- D. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits 2002 (Corrigendum 2012).
- E. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information 2019.
- F. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products 2019.
- G. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources 2021.
- H. IES RP-8 - Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting 2018, with Errata (2020).
- I. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- J. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems 2006.
- K. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices 2020.
- L. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012 (Reaffirmed 2018).
- M. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- N. UL 1598 - Luminaires Current Edition, Including All Revisions.

- O. UL 1598C - Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits Current Edition, Including All Revisions.
- P. 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 placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
 - 2. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. 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.
 - 3. Provide structural calculations for each pole proposed for substitution.
- 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.
 - 2. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.
- C. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
- D. Field Quality Control Reports.
 - 1. Include test report indicating measured illumination levels.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fuses: Five percent of total quantity installed for each type, but not less than two of each type.
- H. 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. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. 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, 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. Provide three 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.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- I. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.
- J. 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.
- K. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.
 - 1. LED Tape - General Requirements:
 - a. Listed.

- b. Designed for field cutting in accordance with listing.
- c. Wet Location Applications: IEC 60529, IP 68 (waterproof) rated.

2.3 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:

- 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
- 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
- 3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

B. Dimmable LED Drivers:

- 1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
- 2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.4 POLES

A. All Poles:

- 1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
- 2. Material: Steel, unless otherwise indicated.
- 3. Shape: Square straight, unless otherwise indicated.
- 4. Finish: Match luminaire finish, unless otherwise indicated.
- 5. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
- 6. Unless otherwise indicated, provide with the following features/accessories:
 - a. Handhole, 3" x 5" in size.
 - b. Anchor bolts with leveling nuts or leveling shims.
 - c. Anchor base cover.

B. Metal Poles: Provide ground lug, accessible from handhole or transformer base.

2.5 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 26 05 33.16 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 26 05 29.
- F. Provide required seismic controls in accordance with Section 26 05 48.
- G. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- H. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
 - 4. Install canopies tight to mounting surface.
 - 5. Unless otherwise indicated, support pendants from swivel hangers.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K. Pole-Mounted Luminaires:
 - 1. Foundation-Mounted Poles:
 - a. Install foundations plumb.
 - b. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
 - c. Tighten anchor bolt nuts to manufacturer's recommended torque.
 - d. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
 - e. Install anchor base covers as indicated.
 - 2. Embedded Poles: Install poles plumb as indicated.
 - 3. Grounding:
 - a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
 - 4. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
- L. Install accessories furnished with each luminaire.
- M. Bond products and metal accessories to branch circuit equipment grounding conductor.
- N. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

- A. Inspect each product for damage and defects.

- B. Operate each luminaire after installation and connection to verify proper operation.
- C. 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. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect.

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. 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

SECTION 27 05 00
GENERAL REQUIREMENTS FOR COMMUNICATIONS SYSTEMS
PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work of this Section consists of providing all required labor, supervision, materials and equipment (except equipment furnished by the Owner to be installed by the Contractor) to satisfactorily complete the work shown on the drawings and/or specified in all Sections of Division 27 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete and fully operating facility. The work shall include but not be limited to the following:
 - 1. Furnish and install all required in-place equipment, conduits, conductors, cables and any miscellaneous materials for the satisfactory interconnection and operation of all associated communication systems.

1.2 RELATED WORK:

- A. This Section provides the basic Communication Requirements which supplement the General Requirements of Division 1 and apply to all Sections of Division 27.

1.3 STANDARDS AND CODES:

- A. All work and material shall be in compliance with and according to the requirements of the latest revision of the following standards and codes:
 - 1. California Electrical Code (CEC)
 - 2. American National Standards Institute (ANSI) Publications:
 - a. C2-02 National Electrical Safety Code
 - 3. Code of Federal Regulations (CFR):
 - a. 29 CFR 1910.147 Control of Hazardous Energy (Lock Out/Tag Out)
 - 4. Electronics Industries Association (EIA)
 - 5. Building Industry Consultants Society International (BICSI)
 - 6. Institute of Electrical and Electronics Engineers (IEEE)
 - 7. National Electrical Testing Association (NETA):
 - a. Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, Standard ATS
 - 8. National Electrical Manufacturers Association (NEMA)
 - 9. Occupational Safety and Health Act (OSHA) Standards
 - 10. State of California Public Utilities Commission:
 - a. General Order 128 Rules for Construction of Underground Electric Supply and Communication Systems
- B. Variances: In instances where two or more codes are at variance, the most restrictive requirement shall apply.
- C. Underwriter Laboratories (UL) listing is required for all equipment and materials where such listing is offered by the Underwriters Laboratories. Safety labeling and listing by other organizations, such as ETL Testing Laboratories, may be substituted for UL labeling and listing if acceptable to the Owner. Provide service entrance labels for all equipment required by the NEC to have such labels.

1.4 SUBMITTALS:

- A. As specified in Division 1. Submit to the Engineer shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system specified. Obtain approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review.

- B. Submittals are required for all items, regardless of whether they are furnished as specified or are substituted.
- C. Submittals shall be provided prior to the purchasing and installation of the item(s) being submitted. Any work done prior to the final approval of the submittal shall be done at risk and any modifications, changes, or re-work that may be required resulting from the final submittal review shall be provided by the Contractor at no additional cost to the project.
- D. Information to be submitted includes manufacturer's name, trade name, equipment model number, nameplate data, equipment drawings including: size, layout dimensions and capacity, manufacturer's descriptive literature of cataloged products, diagrams, test data, and performance and characteristic curves as applicable. Furnish project specification and paragraph reference, applicable Federal, Industry and Technical Society Publication References, and years of satisfactory service of each item required to establish contract compliance. Photographs of existing installations and data submitted in lieu of catalog data are not acceptable and will be returned without approval.
- E. If submittal information includes multiple products, items being submitted for approval shall be clearly identified and Items not to be used on the project shall be clearly marked out. Submittals consisting of manufacturer's catalogs without clearly marking out items not being used will be returned as not reviewed.
- F. Organize submittals for equipment and items related to each specification section together as a package.
- G. Submit submittal packages in digital PDF format.
 - 1. Certificates of Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this contract. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements that imply the item does not meet requirements specified, such as "as good as", "achieve the same end use and results as materials formulated in accordance with the referenced publications;" or "equal or exceed the service and performance of the specified material." Certifications shall state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official, authorized to sign certificates of conformance.
- H. Substitutions:
 - 1. The equipment included in the Contract Documents is used to establish standards of quality, utility, size, and appearance. Equipment which in the opinion of the Engineer is equal in quality, utility, size, and appearance will be approved as substitutions to that specified:
 - a. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are approved by the Engineer prior to bidding.
 - 2. Substitutions will be accepted for review where there is a reasonable reason for the substitution. Reasonable reasons include:
 - a. Cost savings to the owner. Include deductive change order with submittal.
 - b. A product with features providing additional benefits to the end user.
 - c. Improved finished environment, lay out of the final installation, or space savings over the specified equipment.
 - d. Delivery considerations.
 - e. Owner's specific requests.

3. Where items are noted as “or equal”, a product of equal design, construction, and performance will be considered.
 4. Any item proposed as a substitute shall be accompanied by the following:
 - a. Drawings and/or data giving sizes, capacities, all pertinent test data, catalog cut sheets, product information, and all other necessary information required to substantiate that the product is equal or exceeds that specified.
 - b. A summary sheet noting each performance characteristic noted in the specification section or elsewhere in the contract documents of the specified product and the corresponding performance characteristics of the proposed substitution. The summary sheet shall contain the following information:
 - 1) Reason for Substitution Request
 - 2) Pertinent Performance Characteristics
 - 3) Specified Product Values
 - 4) Substituted Product Values
 - c. Any substitution request that does not include the above information shall be rejected.
 - d. Refer to the end of this specification section for an example form to be used for substituted products. A Microsoft Word version of the form can be provided to the Contractor for their use upon request.
 5. Substitutions shall be equal, in the opinion of the Engineer, to the specified equipment. The burden of proof of such shall rest with the Contractor. When the Engineer in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted equipment to be equal to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the work, or from any provisions of the Plans or Specifications.
 6. Contractor shall be responsible for coordination of the substituted products with other trades. Provide all additional connectivity, equipment, increased wire/conduit size, installation hardware, testing, and other miscellaneous appurtenances as required for a complete and fully functional installation.
 7. Only one substitution will be considered for each product specified.
 8. Alternate manufacturers must be submitted for approval 10 days prior to bid date unless noted otherwise in Division 1.
 9. The Contractor shall be responsible for all expenses in connection with the substitution materials, process, and equipment, including the effect of his/her substitution on him/her, his/her subcontractor’s or other Contractor’s work. No substitution shall be permitted without written authorization of the Engineer. Any assumptions on the acceptability of a proposed substitution prior to acceptance by the Engineer are at the sole risk of the Contractor.
- I. Change Orders:
1. Where a change to the contract documents would result in a credit due to the Owner or a value add change to the project, provide a detailed change order request for the Engineer to review.
 2. It shall be understood that the Engineer’s review of costs associated with the change order shall not constitute approval of the change order or their associated costs. The Engineer’s review shall be intended to assist the Owner in evaluating the costs associated with the change only. Final approval or rejection of the change order shall be at the discretion of the Owner.
 3. Change order requests shall include the following information:
 - a. Description of the change
 - b. Reference to the document or written direction to make the change:
 - 1) In the case of design-team directed changes, reference the drawing/sketch number or RFI number.

- 2) In the case of Owner-directed changes, reference the email, memo, or other written direction from the Owner and provide a copy of the direction.
- c. Detailed cost breakdown for the change:
 - 1) Line item for each material noting:
 - (a) Material used (e.g. ¾" EMT)
 - (b) Total quantity (e.g. 200lf)
 - (c) Unit cost (e.g. \$2/lf)
 - (d) Total materials cost (e.g. \$400)
 - (e) Unit labor hours (e.g. 6hrs/100lf)
 - (f) Total labor hours (e.g. 12hrs)
 - (g) Hourly rate (e.g. \$90/hr)
 - (h) Total labor cost (e.g. \$1,080)
 - (i) Total labor hours for each position (e.g. Journeyman vs. Superintendent)
 - (j) Total materials cost
 - (k) Overhead
 - (l) Profit
 - (m) Total change order value (positive for value added changes, negative for credits)
- J. Closeout Submittals:
 1. As-built drawings: Submit As-Built Record documents as in accordance with section 3.05 below.
 2. Cost analysis: Submit final cost information including original bid and any change orders broken down by system, material and labor costs (as applicable):
 - a. Public Address System
 - b. CATV System
 - c. Telecom System
 - d. Data System
 - e. Assistive Listening System
 - f. Audio/Visual System
 3. Operation and Maintenance Manuals. Furnish O & M Manuals for equipment where manuals are specified in the equipment specifications or are specified in Division 1. Electrical O & M Manuals shall include as a minimum:
 - a. Copies of equipment supplied on the project.
 - b. Instruction manuals including operation instructions and maintenance requirements/recommendations.
 - c. List of suppliers for all equipment with addresses and telephone numbers.
 - d. List of service support for all equipment with addresses and telephone numbers.
 - e. Copies of all test reports required in Division 27 specification sections.
 - f. Spare Parts: For each piece of equipment, submit a list of recommended spare parts. Include part numbers and the name, address, and telephone number of the supplier.
 - g. Other closeout documentation and test results as required under other sections of the specifications.
 - h. Provide in a single transmittal.
 - i. Warranty for all work, including contractor's general warranty.
 - j. All warranties begin as per the Contract, Division 1 or final acceptance of the Work by the Owner, Architect, Engineer, and Authority Having Jurisdiction, which ever is later:
 - 1) Manufacturer's Warrantees and Guarantees that are longer than the base contract/specified amount are to be provided with the manuals.

- 2) The Contractor is responsible for all Warranty and Guarantee work whether or not the Manufacturer also Warrantees and Guarantees the product.

1.5 CONTRACT DOCUMENTS:

- A. Review the Drawings and Specification Divisions of other trades and perform the electrical work that will be required for the installations:
 1. Should there be a need to deviate from the Drawings and Specifications, submit written details and reasons for all changes to the Engineer for favorable review.
 2. All drawings and divisions of these specifications shall be considered as whole. This contractor shall report any apparent discrepancies prior to submitting bids.
 3. Should there be a conflict or discrepancy between the drawings and specifications, or between different drawings sheets, or between different specification sections, the most expensive option shall be required, at the discretion of the Engineer.
- B. Drawings:
 1. The Drawings shall govern the general layout of the completed construction:
 - a. Locations of equipment, inserts, anchors, panels, pullboxes, manholes, conduits, stub-ups, fittings, outlets, racks, devices and ground connections are approximate unless dimensioned; verify locations with the Engineer prior to installation. Field verify scaled dimensions on Drawings.
 - b. The general arrangement and location of existing conduits, piping, apparatus, etc., is shown as existing on drawings or specified. The drawings and specifications are for the assistance and guidance of the contractor, exact locations, distances and elevations are governed by actual field conditions. Extreme accuracy of data given herein and on the drawings is not guaranteed. Minor changes may be necessary to accommodate work. The contractor is responsible for verifying existing conditions. Should it be necessary to deviate from the design due to interference with existing conditions or work in progress, claims for additional compensation shall be limited to those for work required by unforeseen conditions as determined by the Engineer.

1.6 COORDINATION:

- A. Coordinate the communications work with the other trades, code authorities, utilities and the Engineer:
 1. Failure to accomplish this coordination is not a basis for additional cost reimbursement to the Contractor.
 2. Coordinate does not mean to only send a Request For Information. Coordinate implies that the contractor is to take the lead in bringing all of the necessary organizations together to coordinate the work and to provide for the associated costs.
- B. Where connections must be made to existing installations, properly schedule all the required work, including the power or communication system shutdown periods. Schedule and carry out shutdowns so as to cause the least disruption to operation of the Owner's facilities:
 1. Include costs for work during non-normal working hours and temporary facilities as may be required.
 2. Include costs as necessary for sub-contractors to accomplish the specified work.
- C. When two trades join together in an area, make certain that no communications work is omitted. Failure to accomplish this coordination is not a basis for additional cost reimbursement to the Contractor.
- D. Operations:
 1. Perform all work in compliance with Division 1:
 - a. Keep the number and duration of power shutdown periods to a minimum.
 - b. Show all proposed shutdowns and their expected duration on the construction schedule:

- 1) If the construction schedule is created and maintained by others, make sure that the associated information is incorporated.
 - 2) Failure by the Contractor to properly schedule and plan for such activities is not a basis for additional compensation.
 - c. Carry out shutdown only after the Engineer has favorably reviewed the schedule. Submit power/communications interruption schedule 15 days prior to date of interruption. Failure to provide schedule with adequate review time may result in rescheduling of the work at the Contractor's expense.
- E. Construction telephone:
1. See Division 1 Temporary Utilities.
- F. Storage:
1. Provide adequate storage for all equipment and materials which will become part of the completed facility so that it is protected from sun, weather, condensation, dust, water, or construction operations.
- G. Damaged Products:
1. Notify the Engineer in writing in the event that any equipment or material is damaged. Obtain approval from the Engineer before making repairs to damaged products.
- H. Order material in such a timely manner and after approval of the same so as to insure that the approved material is available to be installed on site in a timely manner. Additional costs or substitutions necessitated because the Contractor failed to order material in a timely manner are not reimbursable. Costs associated with processing of paperwork by the owner and design consultants resultant of such failures to coordinate the work by the Contractor shall have such costs reimbursed by the Contractor.

1.7 LOCATIONS

- A. General:
1. Use equipment, materials and wiring methods suitable for the types of locations in which they are located:
 - a. Dry Locations:
 - 1) All those indoor areas which do not fall within the definition below for Wet Locations and which are not otherwise designated on the Drawings.
 - b. Wet Locations:
 - 1) All locations exposed to the weather, whether under a roof or not, unless otherwise designated on the Drawings.

1.8 SAFETY AND INDEMNITY:

- A. The Contractor is solely and completely responsible for conditions of the job site including safety of all persons and properly during performance of the work. This requirement will apply continually and not be limited to normal working hours:
1. No act, service, drawing review or construction review by the Owner, the Engineer or their Consultants is intended to include reviews of the adequacy of the Contractors safety measures in or near the construction site.
 2. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify, and defend the Owner, the Engineer, their consultants, and each of their officers, agents and employees from any and all liability claims, losses, or damage arising out of or alleged to arise from bodily injury, sickness, or death of a person or persons and for all damages arising out of injury to or destruction of property arising directly or indirectly out of or in connection with the performance of the work under this Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the construction contract documents, but not including liability that may be due to the sole negligence of the Owner, the engineer, their Consultants or their

officers, agents and employees.

PART 2 PRODUCTS

2.1 STANDARD OF QUALITY:

A. Material and Equipment:

1. Provide materials and equipment that are new and are current products of manufacturers regularly engaged in the production of such products. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year period includes use of equipment and materials of similar size under similar circumstances. For uniformity, only one manufacturer will be accepted for each type of product.

B. Service Support:

1. Submit a certified list of qualified permanent service organizations including their addresses and qualification for support of the equipment. These service organizations shall be convenient to the equipment installation and able to render service to the equipment on a regular and emergency basis during the warranty period of the contract.

C. Manufacturer's Recommendations:

1. Where installation procedures are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendation shall be cause for rejection of the equipment or material.

2.2 NAMEPLATES:

- #### A. For each piece of electrical equipment, provide a manufacturer's nameplate showing his name, location, the pertinent ratings, the model designation, and shop order number.

- #### B. Additionally, identify each piece of equipment and related controls with a rigid laminated engraved plastic nameplate. Unless otherwise noted, nameplates shall be melamine plastic 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 1 by 2.5 inches unless otherwise noted. Where not otherwise specified, lettering shall be a minimum of 0.25 inch high normal block style. Engrave nameplates with the inscriptions indicated on the Drawings and, if not so indicated, with the equipment name. Securely fasten nameplates in place using two stainless steel screws or, where favorably reviewed by the Engineer, with epoxy cement. Where no inscriptions are indicated on the Drawings, furnish nameplates with appropriate inscriptions furnished by the Engineer upon prior request by the Contractor. At a minimum, these nameplates shall be provided for:

1. MDF Racks / Cabinets
2. IDF Racks / Cabinets
3. Signal Termination Cabinets (STC)
4. Headend equipment (e.g. Clock/PA headend)

2.3 FASTENERS:

- #### A. Fasteners for securing equipment to walls, floors and the like shall be either hot-dip galvanized after fabrication or stainless steel.

2.4 FINISH REQUIREMENTS:

A. Equipment:

1. Refer to each electrical equipment section of these Specifications for painting requirements of equipment enclosures. Repair any final paint finish which as been damaged or is otherwise unsatisfactory, to the satisfaction of the Engineer.

- #### B. In finished areas, paint all exposed conduits, boxes and fittings to match the color of the surface to which they are affixed.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Ensure that all equipment and materials fit properly in their installation.
- B. Perform any required work to correct improperly fit installation at no additional expense to the owner.
- C. Equipment Installation:
 - 1. Provide the required inserts, bolts and anchors, and securely attach all equipment and materials to their supports.
 - 2. Mount all metal panels which are mounted on or abutting concrete walls or any outside walls a minimum of ¼ inch from the wall, and paint the back sides of the panels with Bituminous Coating, Rust-oleum C9578 Coal Tar Epoxy Coating or approved equal. Film thickness shall be 10 mils minimum.
- D. Cutting, Drilling and Welding:
 - 1. Provide the required cutting, drilling welding that is required for the electrical construction work. Comply with Division 1 requirements.
 - 2. Structural members shall not be cut or drilled, except after approval by the Engineer. Use a core drill wherever it is necessary to drill through concrete or masonry.
 - 3. Provide the required welding for equipment supports. Conduits and fittings shall not be welded to structural steel. Where welding is required, it shall be accomplished by tradesmen certified to do such work. Provide fire and other protection as appropriate.

3.2 FIELD TESTS:

- A. Test shall be in accordance with Acceptance Testing recommendations issued by the NIA/TIA for telecommunications equipment and the manufacturers recommendations for equipment other than telephone or data systems.
- B. Perform equipment field tests and adjustments. Properly calibrate, adjust and operationally check all components, and demonstrate as ready for service. Make additional calibration and adjustments if it is determined later that the initial adjustments are not satisfactory for proper performance. Perform equipment field test for equipment where equipment field tests are specified in the equipment Specifications. Give sufficient notice to the Engineer prior to any test so that the tests may be witnessed.
- C. Provide instruments, other equipment, temporary facilities as may be necessary, and material required for the tests. These shall be of the type designed for the type of tests to be performed and shall be calibrated by a recognized testing laboratory within three months prior to testing.
- D. Operational Tests: Operationally test all drops to demonstrate that the circuits and equipment have been properly installed and adjusted and are ready for full-time service. Demonstrate the proper functioning of drops in all modes of operation.
- E. Re-testing will be required for all unsatisfactory tests after the equipment or system has been repaired. Re-test all related equipment and systems if required by the Engineer. Repair and re-test equipment and systems which have been satisfactorily tested but later fail, until satisfactory performance is obtained.
- F. Perform calibration and adjustment on all equipment. Where the values for adjustment are not shown on the Drawings, obtain the proper values from the Engineer.
- G. Maintain records of each test and submit five copies to the Engineer when testing is complete. All tests shall be witnessed by the Engineer. These records shall include:
 - 1. Name of equipment tested.
 - 2. Date of report.
 - 3. Date of test.

4. Description of test setup.
5. Identification and rating of test equipment.
6. Test results and data.
7. Name of person performing test.
8. Owner or Engineer's initials.

H. Items requiring testing as a minimum:

1. Data system.
2. Telephone system.
3. Intercom/PA system.
4. CATV system.
5. Sound/Assistive listening system.
6. Audio/Visual system.

3.3 PAINTING OF EQUIPMENT:

- A. Factory Applied: Communication equipment shall have factory applied painting system which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test and the additional requirements specified in the technical section.
- B. Field Applied: Paint communication equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.4 SIGNAGE AND IDENTIFICATION:

- A. Identify system components, wiring, and cabling complying with TIA-606-B.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 1 (C1 - single telecom room) and Class 2 (C2 - multiple telecom rooms) level of administration including optional identification requirements of this standard.
- C. Nameplate Mounting:
 1. Provide number, location and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two stainless steel sheet-metal screws or two rivets.

3.5 RECORDS:

- A. Maintain one copy of the contract Drawing Sheets on the site of the work for recording the record "as built" condition. After completion of the work, the Contractor shall neatly and carefully mark the work as actually constructed, revising, deleting and adding to the Drawing Sheets as required. The following requirements shall be complied with:
 1. Drawings and associated as-built changes shall be completed in AutoCAD or Revit and submitted in CAD/Revit as well as PDF format. Documents with hand-written changes or with RFI responses and field sketches pasted on shall not be acceptable. Engineer shall make digital backgrounds of original contract documents available for Contractor's use upon request.
 2. Cable Size and Type: Provide the size and type of each cable installed on the project.
 3. Substructure: Where the location of duct lines, adjacent utilities, cable boxes, and manholes are found to be different than shown, carefully mark the correct location on the Drawings. Work shall be dimensioned from existing improvements.
 4. Record (As Built) Drawings: At the completion of the Work the Contractor shall provide a set of record "as built" drawings over to the Owner for his use.
 - a. Record drawings are required to be transmitted within 30 days of beneficial occupancy.
 - b. Transmittal and approval process:
 - 1) Contractor is to transmit one printed copy for review and comment.

- 2) After acceptance of the above, the Contractor is to transmit three printed sets and one reproducible set.
- 3) Contractor to provide information on their company in the margin of record drawings along with the date of the revisions and the associated revision number.

3.6 POSTED OPERATING INSTRUCTIONS:

- A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
 1. Single line diagrams, wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 2. Start up, proper adjustments, operating and shutdown procedures.
 3. Safety precautions.
 4. The procedure in the event of equipment failure.
 5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

3.7 INSTRUCTION TO OWNER'S PERSONNEL:

- A. Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or systems has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.
- B. Contractor shall video record all training sessions and shall provide the Owner with a copy of the recording at the conclusion of the training. Recording shall be in digital video format (MP4, AVI, or similar) and shall be provided on USB stick or DVD labeled with the Contractor's contact information, the training topic, and date of training.
- C. Contractor shall maintain an attendance sheet from each session which contains the following information:
 1. Attendees with associated arrival and departure time.
 2. Topics covered.
 3. Information provided.
 4. Signatures of attendees taken at the completion of the session.

3.8 CLEAN UP:

- A. Thoroughly clean all soiled surfaces of installed equipment and materials.
- B. Upon completion of electrical work, remove all surplus materials, rubbish, and debris that accumulated during the construction work. Leave the entire area neat, clean, and acceptable to the Engineer.

END OF SECTION

SECTION 27 10 00
WIRE AND CABLES FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work of this Section consists of providing all wire and cable rated 600 volts or less, including splices and terminations, as shown on the Drawings and as described herein.

1.2 RELATED WORK:

- A. See the following Specification Section for work related to the work in this Section:
 - 1. 27 05 00 General Requirements for Communication Systems
 - 2. 26 05 33.13 Conduit for Electrical Systems
 - 3. 26 05 33.16 Boxes for Electrical Systems
 - 4. 26 05 26 Grounding and Bonding for Electrical Systems

1.3 STANDARDS AND CODES:

- A. Work and materials shall be in compliance with and according to the requirements of the latest revision of the following Standards and Codes:
 - 1. American Society for Testing and Materials (ASTM):
 - a. B3-01, Specification for Soft or Annealed Copper Wire
 - b. B8-99, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
 - c. B173-01a, Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors
 - 2. Federal Standards (FED. STD.):
 - a. 228, Methods of Testing Insulated Cable and Wire
 - 3. Federal Specifications (FS):
 - a. A-A-59544, Cable and Wire, Electrical
 - b. A-A-55809, Pressure Sensitive Electrical Plastic Insulation Tape
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. WC 70-1999/ICEA S-95-658-1999, Cross-Linked Thermosetting Polyethylene, Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 - 5. National Fire Protection Association (NFPA), National Electrical Code (NEC) - Latest Revision
 - 6. California Electrical Code (CEC)
 - 7. Underwriters Laboratories (UL):
 - a. 44-83 (R1988), Rubber-Insulated Wires and Cable
 - b. 83-1983 (R1989), Thermoplastic-Insulated Wires and Cables
 - c. 510-1986, Insulating Tape

1.4 SUBMITTALS:

- A. As specified in Division 1 and Section 27 05 00.
 - 1. Catalog Data: Provide manufacturer's descriptive literature.
 - 2. Single Submittal: A single complete submittal is required for all products covered by this Section.

PART 2 PRODUCTS

2.1 CONDUCTORS:

- A. General: Conductors shall be copper, Class B stranded and of the sizes indicated. All conductors 120 volts and above shall be in raceway unless otherwise noted. Minimum power and control wire size shall be No. 12 AWG unless otherwise specified by the Owner's Representative. All cable used on this Project shall be of the same type and conductor material.

- B. Unless otherwise noted, conductors #6 and larger shall be XHHW insulation suitable for operation in wet or dry locations at temperatures not to exceed 75C in wet locations and 90C in dry locations. Conductors #8 and smaller shall be THHN in dry locations and THWN/THHN in wet locations. Control Cable shall be THHN.
- C. Insulation Marking: All insulated conductors shall be identified with printing colored to contrast with the insulation color.
- D. Color Coding: As specified in paragraph 3.03.
- E. Special Wiring: Where special wiring is proposed by an equipment manufacturer, submit the special wiring requirements to the Owner's Representative and, if approved, provide same. Special wire shall be the type required by the equipment manufacturer.
- F. Other Wiring: Wire or cable not specifically shown on the Drawings or specified, but required, shall be of the type and size required for the application and as approved by the Owner's Representative.
- G. Terminations:
 - 1. Cable Termination for Copper: Crimp style two hole NEMA spade terminals designed and rated for copper cable.
 - 2. Wire Terminations: Crimp on ring-tongue terminals, insulated sleeve, of proper size for the wire used.
 - 3. End Seals: Heat shrink plastic caps of proper size for the wire on which used.
 - 4. Manufacturer: T&B, Burndy or approved equal.
- H. Manufacturer: BICC General Cable Inc., Southwire, or approved equal.

2.2 TELEPHONE AND DATA STATION DROP CABLE:

- A. General:
 - 1. Station Drop Cable refers to MDF-to-jack and IDF-to-jack wiring topology
 - 2. Conductor Identification: Conductors shall be pigmented "White/Blue; White/Orange; White/Green & White/Brown."
 - 3. Cable for all exterior, underground or wet locations shall be outdoor rated with water-blocked construction, sunlight and moisture resistance jacket.
 - 4. Cable for all interior plenum locations. Cable shall have Fluorinated Ethylene-Propylene insulation with flame retardant PVC Jacket.
 - 5. Cable for all interior non-plenum locations. Cable shall have Polyolefin insulation with flame retardant PVC Jacket.
 - 6. Jacket Color:
 - a. Data cables: Blue
 - b. Telephone cables: White
- B. Category 6A Unshielded Twisted Pair (UTP) cable:
 - 1. Cable shall be 100-Ohm, 23 AWG, Category 6A 4-pair balanced unshielded twisted pair solid annealed copper.
 - 2. Cable shall be guaranteed to exceed all TIA-568 link and channel performance requirements, and capable of supporting 10GBase-T (802.3an) and ISO/IEC 11801 Class EA applications for a total distance of 100 meters with equipment cords. System is guaranteed to meet all CAT6A requirements for short links and channels down to a 10 foot permanent link (5 meter channel) with a guaranteed 5 dB margin of Alien Crosstalk. Field testing is not required for Alien Crosstalk clearance.
 - 3. Cable shall be characterized to 750 MHz and UL/ETL Listed by the Manufacturer printed on the cable jacket and package, as well as Intertek (ETL) Verified to TIA-568 Category 6A and ISO/IEC 11801 Class EA requirements for channel, link and component performance to support IEEE 10GBASE-T (802.3an) networks

4. Manufacturer shall provide documentation from an independent third-party testing agency that verifies through random sampling that cable components perform at or above the levels contained on their product specifications.
5. The unshielded twisted pair conductors shall be surrounded by a non-conductive aluminum/polyester tape and jacketed with flame-retardant polymer alloy.
6. Outer Diameter: 0.275” max.
7. Cable shall be provided on spools or reels-in-box to reduce risk of kinking cable upon deployment, shall be made by an ISO 9001 and 14001 Certified Manufacturer, and shall be guaranteed to meet or exceed Channel margin characteristics as stated above under Performance.
8. Performance:
 - a. Insertion loss: 3%
 - b. NEXT: 4 dB
 - c. PSNEXT: 5 dB
 - d. ACR-F (ELFEXT): 8 dB
 - e. PSACR-F (PSELFEXT): 8 dB
 - f. Return Loss: 4 dB
 - g. ACR-N: 7 dB
 - h. PSACR-N: 7 dB
 - i. PSANEXT: 4 dB
 - j. PSAACR-F: 10 dB
9. Manufacturer:
 - a. Exterior, underground or wet locations: Berk-Tek Leviton LanMark-10G OSP series or approved equal
 - b. Interior plenum locations: Berk-Tek Leviton LanMark-XTP CX6850 CMP series or approved equal
 - c. Interior non-plenum locations: Berk-Tek Leviton LanMark-XTP CX6850 CMR series or approved equal

2.3 TELEPHONE AND DATA TRUNK CABLE

A. General:

1. Trunk Cable refers to MDF to IDF, IDF to IDF, and IDF to STC wiring topology.
2. Cable for all exterior, underground or wet locations shall be outdoor rated with water-blocked construction, sunlight and moisture resistance jacket.
3. Cable for all interior plenum locations. Cable shall have Fluorinated Ethylene-Propylene insulation with flame retardant PVC Jacket.
4. Cable for all interior non-plenum locations. Cable shall have Polyolefin insulation with flame retardant PVC Jacket.

B. Telephone Trunk Cable:

1. Multi-pair UTP 24 AWG Solid Copper rated Category 5e capable of transmitting analog and digital voice data rates up to 1,000 Mbps. Cable shall meet and exceed ANSI/TIA-568-C.2 Category 5E Specifications and meet IEEE 802.3 10Base-T, 100Base-T, and 1000Base-T standards. Provide pair counts and quantity of cables as required for all devices shown on drawings, plus a minimum of 20% spare .
 - a. Conductor Identification: Conductors shall be pigmented “White/Blue; White/Orange; White/Green & White/Brown.”
2. Manufacturer:
 - a. Exterior, underground or wet locations: Berk-Tek Leviton HyperPlus Category 5e OSP cable series or approved equal.
 - b. Interior plenum locations: Berk-Tek Leviton PowerSum 10059632 Category 5e (25) pair CMP plenum rated cable series or approved equal.

- c. Interior non-plenum locations: Berk-Tek Leviton PowerSum 10061456 Category 5e (25) pair CMR riser rated cable series or approved equal.

C. Data Trunk Cable:

- 1. Fiber optic cable. Meets and or exceeds Bellcore GR-20-CORE and RUS specifications. Cable shall be a hybrid cable type and shall have 24 strands of Single Mode and 24 strands of Multi-Mode. The following chart is a specification chart with minimal requirements for the cable:

| | |
|-------------------------|------------------|
| Fiber Optic Cable | Multimode (OM4) |
| Optical Specs | 50/125 |
| Wavelength (nm) | 850/1300 |
| Max Attenuation (dB/KM) | 3.0/1.0 |
| Min Bandwidth (MHzkm) | 3500/500 |
| Jacket Color | Aqua |
| Fiber Optic Cable | Singlemode (OS2) |
| Optical Specs | 8.3/125 |
| Wavelength (nm) | 1300/1550 |
| Max Attenuation (dB/KM) | 0.5/0.3 |
| Min Bandwidth (MHz/km) | 0.4/0.25 |
| Jacket Color | Yellow |

- a. Cable for all exterior, underground or wet locations shall be outdoor and riser rated with water blocking strength members for strength and surrounded with a fire resistance jacket. Optical fibers placed inside a single gel filled tube with fiber bundle. Indoor/Outdoor Dry Loose-Tube Plenum cable, quantity of strands as required.
 - 1) Manufacturer:
 - (a) OM4+ - Berk-Tek Adventum # LTP-###-XB3010/X5 – OFNR or approved equal cable.
 - (b) OS2 - Berk-Tek Adventum # LTP-###-AB0403 – OFNR or approved equal cable.
- b. Cable for all interior plenum locations shall be plenum rated cable. Cable shall include dielectric yarns that are applied for additional strength and a flame resistant outer jacket. Premises Indoor Tight Buffer Plenum cable, quantity of strands as required,
 - 1) Manufacturer:
 - (a) OM4+ - Berk-Tek # PDP___XB3010/X5 – OFNP Fiber or approved equal cable.
 - (b) OS2 - Berk-Tek # PDP___AB0707 – OFNP Fiber or approved equal cable.
- c. Cable for all interior non-plenum locations shall be riser rated cable. Cable shall include dielectric yarns that are applied for additional strength and a flame resistant outer jacket. Premises Indoor Tight Buffer Riser cable, quantity of strands as required.
 - 1) Manufacturer:
 - (a) OM4 - Berk-Tek, # PDR-###-XB3010/F5 – OFNR Fiber or approved equal cable.
 - (b) OS2 - Berk-Tek, # PDR-###-AB0707 – OFNR Fiber or approved equal cable.

2.4 TAPE:

- A. Tape used for cable marking shall be compatible with the insulation and jacket of the cable and shall be of plastic material. Tape shall conform to FS HH-I-595 and UL 510.

PART 3 EXECUTION

3.1 CABLE INSTALLATION:

- A. Clean Raceways: Clean all raceways prior to installation of cables as specified in Section 27 05 28.33 – Communication System Raceways and Fittings.
- B. Cable Pulling: Exercise care in pulling wires and cables into conduit or wireways so as to avoid kinking, putting undue stress on the cables or otherwise abrading them. No grease will be permitted in pulling cables. Only soapstone, talc, or UL listed pulling compound will be permitted. The raceway construction shall be complete and protected from the weather before cable is pulled into it. Swab conduits before installing cables and exercise care in pulling, to avoid damage to conductors.
- C. Bending Radius: Cable bending radius shall be per applicable code or standard, whichever is more stringent.
- D. Splices: Install cables in one continuous length. Splices shall not be permitted.
- E. Equipment Grounding Conductors: Provide an equipment grounding conductor, whether or not it is shown on the Drawings, in any conduit or any raceway.
- F. Wiring at Hinges: For cables crossing hinges, utilize extra flexible stranded wire, make up into groups not exceeding 12, and arrange so that they will be protected from chafing when the hinged member is moved.
- G. Damaged Cables: Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- H. Cold Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating cable.
- I. Service Loops: In communications rooms where cables are terminated, install a 10-foot long service loop on end of each cable prior to termination.
- J. All wiring and cable shall be supported from the structure above. All wiring over 100 volts shall be installed in conduit except as noted in Section 27 05 28.32. All wiring below 100 volts shall be installed in conduit unless otherwise noted.
- K. Low Voltage Cables:
 - 1. All cables provided inside buildings shall be plenum rated.
 - 2. All cables provide outside buildings shall be outdoor rated, gel filled cables.
 - 3. All low voltage wires and cables concealed in walls shall be run in EMT conduit from flush outlet boxes to above accessible ceilings. Provide conduit where cables penetrate floors and fire walls above ceilings. Where low voltage cables run parallel to line voltage (over 120 volts), they shall be installed a minimum of 12 inches apart.
 - 4. Contractor installing cables shall be manufacturer certified to pull and install cables of the types and ratings noted herein.
 - 5. Maximum horizontal cabling distance for Copper data cables shall not exceed 295 feet per EIA/TIA 568B Standards. Contractor shall notify engineer prior to commencement of work of any cabling exceeding the 295 foot maximum distance.
 - 6. Do not bend cables to a radius of less than eight (8) times the cable diameter.
 - 7. All cables shall be provided with plastic identification tags in each end, identify the source of the cables and the destination of the cables.
- L. Fiber Optic Backbone Cables:

1. Splices in the Fiber Optic backbone cables and UTP station cables are not permitted. There are no exceptions unless during the installation period unless the contractor finds a problem with the means and method of construction. The contractor shall be responsible to obtain Owner's permission in writing for any splices prior to the splice being installed.
2. Contractor shall place all Fiber Optic backbone cabling in accordance with these specifications, and as indicated on the Drawings. Place Fiber Optic backbone cabling between the Main Distribution Frame (MDF) and the Intermediate Distribution Frames (IDF's) unless otherwise noted.
3. Contractor installing fiber optic cables shall be manufacturer certified to pull and install such cables.
4. Fiber Optic cable used for underground portions of the backbone (if applicable) must be suitable for underground use.
5. Fiber Optic Bending Radius: Indoor rated fiber optic cable shall have minimum bending radius of 3.9 inches and outdoor rated fiber optic cable shall have minimum bending radius of 6 inches.
6. All cables shall be provided with plastic identification tags in each end, identify the source of the cables and the destination of the cables.

3.2 CABLE TERMINATIONS AND SPLICES:

A. Splices:

1. All power, fire alarm, telephone, and CATV/MATV television cables shall be continuous below grade (i.e. no splices or terminations below grade).
2. All fiber optic cable and data wiring shall be continuous from end to end. No splices shall be permitted.
3. Use UL listed wirenuts for line voltage branch circuits in dry locations.

B. Terminations: Shall comply with the following:

1. Make up and form cable and orient terminals to minimize cable strain and stress on device being terminated on.
2. Burnish oxide from conductor prior to inserting in oxide breaking compound filled terminal.

3.3 FIELD TESTS

- A. Refer to individual system specification sections for testing requirements.

END OF SECTION

SECTION 27 20 00
DATA COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work of this Section consists of providing components for the data communication systems. Provide racks, cabinets, pathways, boxes, cabling, terminations, patch cords, patch panels, jacks and testing as required.

1.2 RELATED WORK:

- A. See the following specification sections for work related to the work in this Section:
 - 1. 27 05 00 General Requirements for Communication Systems
 - 2. 27 10 00 Wire and Cables for Communication System
 - 3. 26 05 26 Grounding and Bonding for Electrical Systems

1.3 STANDARDS AND CODES:

- A. Work and materials shall be in compliance with and according to the requirements of the latest revision of the following standards and codes:
 - 1. American National Standards Institute (ANSI) Standards:
 - a. ANSI X3T9.5 Fast Ethernet 100Base-T LAN: Defines standard for 100 Mb/s LAN based on either Fiber Optic cable or Unshielded Twisted Pair (UTP)
 - 2. Telecommunications Industry Association / Electronic Industries Alliance (TIA/EIA) Standards:
 - a. TIA/EIA 455 Reference Guide for Fiberoptic Testing Procedures
 - b. TIA/EIA 472 General Specifications for Fiberoptic Cables
 - c. TIA/EIA 492 Generic Specification for Optical Waveguide Fibers
 - d. TIA/EIA 568B Commercial Building Telecommunications Cable Standard
 - e. TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces
 - f. TIA/EIA 598 Fiber Optic Cable Color Coding
 - g. TIA/EIA 606 Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings
 - h. TIA/EIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standards:
 - a. IEEE 802.3 Ethernet 10Base-T LAN: Defines media and distance requirements for 10Mb/s LAN (issued in October 1990)
 - b. IEEE 802.3z Gigabit Ethernet 1000Base SX and LX LAN: Defines media and distance requirements for 1000Mb/s LAN
 - 4. Underwriters Laboratories (UL) Standards:
 - a. UL 910 Test method of Fire and Smoke Characteristics of Electrical and Optical Cables Used in Air Handling Spaces
 - b. UL 1666 Standard Flame test for Flame Propagation Height of Electrical and Optical Cable Installed Vertically in Shafts

1.4 QUALIFICATIONS:

- A. The telecommunications contractor shall have at least five years experience providing similar work, and shall provide a minimum of five references for similar projects completed with the last five years.
- B. The telecommunications installer(s) shall be certified category 5e and fiber optic cable installer(s) and shall provide proof of certification.

1.5 SUBMITTALS:

- A. Shop Drawings - In accordance with Section 27 05 00.
- B. Submit the following items:
 - 1. Manufacturer's Catalog Data: Manufacturer's original catalog cuts and original description of data of all material and equipment with sufficient information provided so that the exact function of each device is known.
 - 2. Description of conductors to be used with a statement that all wire shall be in conduit.
 - 3. Floor plan of the point to point connections.
 - 4. Diagram of the wiring circuitry.
 - 5. Riser diagram.
- C. Single Submittal: A single complete submittal is required for all products covered by this Section.
- D. Closeout Submittals: Submit operation and maintenance data for all components of the telecommunications equipment specified herein. Submit certified test results. Submit in accordance with Division 1.

1.6 WARRANTY:

- A. Manufacturer shall provide a one year warranty for all system components.

PART 2 PRODUCTS

2.1 FIBER OPTIC TERMINATION PANEL (PATCH PANEL):

- A. Minimum performance specifications: Suitable for use with specified Fiber Optic cables. Must meet requirements of TIA/EIA T586B.
- B. Provide Zirconia Ceramic sleeve, SC - type ports.
- C. Panels for MDF's shall be mountable in a standard 19-inch equipment rack. Provide minimum 20% spare connection capacity.
 - 1. Manufacturer: Leviton 5RXXX series or approved equal.
- D. Panels for IDF's shall be mountable in a standard 19-inch equipment rack with minimum capacity for 36 fiber connections. Provide minimum 20% spare connection capacity or minimum 12 ports whichever is larger.
 - 1. Manufacturer: Leviton 5R430-00N or approved equal.
- E. Provide cable management retaining brackets on the back of the panels or other means of securing cables being terminated. Cable tie down bars, support and strain relief and other wire management devices to be placed between each patch panel. Ensure wire management maintains recommended bend radius, and has storage for up to 2 meters of excess cable per coupling.
- F. Store 2 meters of excess cable in purpose designed cable storage.

2.2 FIBER OPTIC PATCH CORDS:

- A. Minimum performance specifications: Suitable for use with specified Fiber Optic cables. Must meet requirements of TIA/EIA T586B.3.
- B. Fiber optic cable specifications:
- C. Connector style: SC - SC .
- D. Density: Duplex.
- E. Cable listing: OFNR
- F. Length: 3 meters

| | | |
|-------------------|-----------|-------------|
| Fiber Optic Cable | multimode | single mode |
|-------------------|-----------|-------------|

| | | |
|-------------------------------|----------|-----------|
| | 62.5/125 | 8.3/125 |
| Wavelength (nm) | 850/1300 | 1310/1550 |
| Max Attenuation (dB/KM) | 3.5/1.0 | 0.5/0.4 |
| Min Bandwidth (MHzkm) | 220/600 | 0.4/0.25 |
| Gigabit Ethernet Min Distance | 300/550 | NA |
| Color | orange | yellow |

- G. Cable lettering must be legible and shall contain the following information:
 1. Manufactures name.
 2. Fiber size.
 3. Fiber Grade.
 4. UL Listing.
 5. Manufacturer's Trade Mark.
 6. Sequential foot markings, in two-foot increments.
- H. Fiber optic connectors:
 1. Zirconia Ceramic tipped, SC - type plug, suitable for use with specified Fiber Optic cable. Maximum insertion loss across mated-pair: Less than 0.8 dB.
- I. Acceptable manufacturers include Leviton, Berk-Tek, Lucent Technologies, Siecor, CommScope or approved equal.

2.3 DATA SWITCHES:

- A. All active equipment such as data switches, hubs and/or routers will be furnished by the owner, installed by the contractor.

2.4 UTP DATA WIRE TERMINATION PANELS (PATCH PANELS):

- A. Minimum performance specifications: Must meet requirements for Category 6A of TIA/EIA.
- B. Provide standard 8-pin, 8-position, RJ-45 style modular patch panels with printed circuit board IDC 110-type connectors, capable of 4-pair, UTP cable termination and wired in an TIA/EIA configuration. Connector spring wire contacts shall be phosphor bronze plated with 50 microinches of gold over 100 microinches of nickel.
- C. Panels shall be mountable in a standard 19-inch equipment rack with capacity for up to 48 modular RJ-45 ports. Ports shall have individual numbers and white labels. Panels shall be UL listed and labeled Cat 6A. Provide minimum of 20% spare port capacity.
- D. Provide cable management retaining brackets on the back of the panels or other means of securing cables being terminated. Horizontal wire management devices to be placed between each patch panel.
- E. Manufacturer: Cat 6A - Leviton 6910G-U48 or approved equal.

2.5 UTP DATA PATCH CORDS:

- A. Provide four pair UTP 24 AWG solid copper. Cable shall be PVC rated. Cross-connect patch cords used on "DATA" cross-connects must meet the impedance, attenuation and NEXT requirements for Category 6A horizontal cable of TIA/EIA.
- B. Provide one patch cord for each patch panel for each data outlet.
- C. Patch cords shall be standard manufacture’s length, minimum 5 feet.
- D. Patch cords shall be factory manufactured with protective strain relief boot on each male plug, hand crimping is not acceptable.
- E. Coordinate cross connections with Owner’s representative.
- F. Manufacturer: Berk-Tek, Leviton or approved equal.

2.6 MODULAR DATA OUTLETS:

- A. Unless otherwise noted, provide single gang, modular voice/data outlets.
- B. Data Jacks must meet the minimum performance specifications for Category 6A of TIA/EIA. All 8-position, modular jack inserts for data locations shall comply with TIA/EIA T568B specifications.
 - 1. Modular jacks shall be engraved 'CAT 6A' on the face of the jack insert.
- C. Contractor shall coordinate data wiring scheme (T568B or T568A) with owner.
- D. All components shall be UL listed.
- E. Unless otherwise indicated provide insert and faceplate colors:
 - 1. Single gang wall plate, white with two labels and label covers.
 - 2. Provide 4 port unless otherwise noted, coordinate number of ports with drawings.
 - 3. Data jack, blue.
 - 4. Blank jack (where applicable), white.
- F. Manufacturer: Ortronics OR-KSFP series or approved equal.

2.7 MAIN DISTRIBUTION FRAME (MDF) AND INTERMEDIATE DISTRIBUTION FRAME (IDF) - EQUIPMENT MOUNTING RACKS:

- A. Provide 19 inch floor mounted 6061-T6 aluminum rack, 7' 0" high with top and bottom angle for solid support. Rack shall have mounting holes for standard equipment support.
- B. Provide duplex receptacle connected to dedicated circuit and horizontally mounted power strip with integral surge protection (equal to Wiremold # 7011 BDS20R) on each rack.
- C. Provide horizontal and vertical cable management system appropriate for type of cabling being installed including:
 - 1. One horizontal cable management panel per patch panel, with cable supports and strain relief.
 - 2. Two single sided vertical cabling sections per rack.
 - 3. Grounding terminal blocks.
 - 4. Provide 12" open web cable tray above rack.
- D. Provide seismic restraints as required to meet appropriate codes.
- E. Manufacturer: Chatsworth or approved equal.

PART 3 EXECUTION

3.1 CABLE & WIRE INSTALLATION:

- A. General:
 - 1. All data communications cables shall be terminated and tested under this contract.
- B. Station Cables:
 - 1. Install station cabling, outlets and jacks as detailed on the Drawings. The typical configuration for most outlets is two unshielded twisted pair (UTP) cables of 4 pairs each.
 - 2. Each data outlet shall be clearly marked with the MDF/IDF, patch panel and port number to which they are connected.

3.2 QUANTITIES AND LOCATIONS OF ITEMS:

- A. Location and placement of splices, patch panels and other distribution hardware shall be as shown on the Drawings or defined herein. Where Drawings are not specific as to placement, refer below.
- B. Quantities of racks, cabinets, splices and patch panels shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The contractor is responsible for providing the correct quantities of racks, patch panels, connectors and

appurtenances necessary to terminate, cross connect and patch the volume of cable described herein and shown on the Drawings. Where less than all of the capacity of a patch panel is used to terminate cables, the Contractor shall provide the Owner with the number of connecting blocks, coupling panels, and couplings to completely fit out the patch panel:

1. Properly install freestanding equipment mounting rack(s), securely mounted to floor, walls and structure above to meet all sway bracing and seismic requirements:
 - a. Cable tray shall be installed directly above rack. Brace tray to walls and structure above.
2. Provide lockable wall mounted equipment cabinets securely mounted to walls.
3. Rack mount Fiber Optic Patch Panels and UTP Patch Panels installed at locations as noted on the drawings. Complete with all necessary hardware.
4. MDF/IDF patch panels for station outlets shall be clearly marked to indicate the room/location served by each port.

3.3 CABLE TERMINATIONS:

A. Fiber Optic cables:

1. After dressing the cable to its final destination, sheath shall be removed to a point that allows the conductors to be splayed and terminated in a neat and uniform fashion. At this point all fibers will be terminated in strict compliance with the manufacturers instructions.
2. Terminate both ends of each fiber optic cable with a SC type port, per manufacturer's recommendations. After termination, mount all connectors in fiber optic termination panels and label appropriately.

B. UTP cables:

1. Each cable shall be terminated on an 8-pin modular jack as indicated in this specification section. Terminate each cable on an TIA/EIA T568 compliant outlet jack matching the cable's specification.
2. Cable pair twists shall be maintained up to within 0.25 inch of the point of termination. Under no circumstances shall cable pairs be untwisted or otherwise altered prior to termination.

3.4 INSTALLATION OF WALL PLATES:

- A. General - Plates shall match the style of the device and shall be plumb within 1/16-inch of the vertical or horizontal.
- B. Interior Locations, Finished Walls: Install non-metallic plates so that all four edges are in continuous contact with the finished wall surfaces. Plaster filling will not be permitted. Oversized plates or sectional plates are not acceptable and shall not be used. If wall finish will not accommodate proper mounting of the plate, the situation shall be brought to the attention of the architect and the wall finish replaced appropriately.
- C. Interior Locations, Unfinished Walls: Install stainless steel.
- D. Future Locations: Install blanking cover plates on all unused outlets.
- E. Prior to installation, coordinate labeling conventions with owner. Provide typed label(s) for faceplate, indentifying each jack on faceplate, uniquely indentifying source and circuit number supplying jack, unless otherwise noted.

3.5 GROUNDING:

- A. Provide dedicated ground at MDF and each IDF. Bond all equipment to ground with insulated ground conductors.

3.6 TESTING:

A. Fiber Optic Cable Testing:

1. Pre-installation testing:

- a. Fiber Optic cables: Perform visible light continuity checks on each fiber. If one end is not accessible: perform OTDR test to assure fiber continuity.
2. Post installation testing:
 - a. After installation of connectors, visually inspect each fiber end-face at 10x magnification. Refinish fibers with visible defects and/or striations in the core area.
 - b. Perform end-to-end, bi-directional attenuation (loss) test for each fiber strand at 850 NM and 1300 NM wavelengths. Conduct tests in accordance with TIA/EIA-526-14, Method B and with test instrument manufacturers' printed instructions.
 - c. Demonstrate that measured link loss does not exceed the "worst case" allowable loss which is defined as the sum of: the connector losses (based on the number of mated connector pairs at the TIA/EIA-568 maximum allowable loss) and the Fiber Optic cable loss (based on length and the TIA/EIA-568 maximum allowable loss.)
 - d. Strands whose measured attenuation fall outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, an OTDR shall be used to: determine the-true loss for each connector pair, the exact length of the fiber and to identify the absence of any core damage,
 - e. Faults related to connectorization shall be corrected, and the fiber re-tested as stated in prior paragraphs above, until acceptable attenuation measurements are recorded.
 - f. Where defects are found inherent-in the fiber itself - replace any cable having fewer than the manufacturers guaranteed number of serviceable fibers.
 - g. Submit the following information regarding the Fiber Optic cable testing:
 - 1) Cable number, fiber count, individual fiber numbers, connector types, number of connectors/ patches, calculated maximum link loss, length of run, measured link loss for each fiber.
3. Recommended test equipment (obtain approval of Owner prior to using substitute test equipment):
 - a. Fiber Optic power meter and Light Source: Siecor CPM-850/1300 meter and OS-100D Light Source or approved equal.
 - b. OTDR: Tektronix TFP2 FiberMaster, Easer Precision TD-2000 or equal with 850 NM and 1300 NM emitter modules and hard copy printout or approved equal.
 - c. Fiber Optic inspection scope: Cambridge Instruments 10X fiber-scope or approved equal.
- B. Paired and Multi-Conductor UTP Cable Testing:
 1. After terminating both ends of all UTP cables, but before any cross connects are installed, test all UTP station cables for attenuation and cross-talk (NEXT) to 100 MHz. Test all UTP cables for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
 2. After installing cross-connects, perform end-to-end testing of each cross connected cable pair for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
 3. For multi-pair cables: For 100 pair or smaller replace entire cable if bad pair is found. For larger pair count cables, replace if more than 1% of pairs are bad.
 4. Submit the following information regarding the UTP station cable testing:
 - a. Cable number, cable type, pair or conductor count; individual pair or conductor numbers; number of cross connects and/or patches in each pair; results of each test for each pair or conductor; total number of serviceable pairs or conductors in cable.
 - b. Information required above shall be provided in printed format only.
 5. Recommended test equipment (Contractor shall obtain approval of Owner in writing prior to using substitute test equipment):
 - a. Fluke DSP 1100 SR, no known equal. Equipment shall be equipped with latest software. Contractor shall refer to Owner to obtain required set-up parameters.

3.7 ACCEPTANCE:

- A. Upon receipt of the Contractor's documentation of proposed cable testing, the Owner will have the right to review and observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner is totally satisfied, that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

3.8 RECORD DRAWINGS:

- A. The Project record as-built drawings shall show the types and locations of installed:
 - 1. Fiber Optic Cables.
 - 2. Station Cables/Outlets.
 - 3. Main Distribution Frames.
 - 4. Intermediate Distribution Frames.
 - 5. Patch panels.
- B. The Project record as-built drawings shall identify numbering on each cable identification label.

END OF SECTION

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SECTION 27 30 00
VOICE COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work of this Section consists of providing components for voice communications systems. Provide racks, cabinets, pathways, boxes, cabling, terminations, patch panels, 66 and/or 110 blocks, jacks and testing as required.

1.2 RELATED WORK:

- A. See the following specification sections for work related to the work in this Section:
 - 1. 27 05 00 General Requirements for Communication Systems
 - 2. 27 10 00 Wire and Cables for Communication System
 - 3. 26 05 26 Grounding for Electrical Systems

1.3 STANDARDS AND CODES:

- A. Work and materials shall be in compliance with and according to the requirements of the latest revision of the following standards and codes:
 - 1. EIA/TIA Standards:
 - a. EIA/TIA 568B Commercial Building Telecommunications Cable Standard
 - b. EIA/TIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces
 - c. EIA/TIA 606 Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings
 - d. EIA/TIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 2. IEEE Standards:
 - a. IEEE 802.3 Ethernet 10Base-T LAN: Defines media and distance requirements for 10Mb/s LAN (issued in October 1990)
 - b. IEEE 802.3z Gigabit Ethernet 1000Base SX and LX LAN: Defines media and distance requirements for 1000Mb/s LAN
 - 3. UL Standards:
 - a. UL 910 Test method of Fire and Smoke Characteristics of Electrical and Optical Cables Used in Air Handling Spaces
 - b. UL 1666 Standard Flame test for Flame Propagation Height of Electrical and Optical Cable Installed Vertically in Shafts

1.4 QUALIFICATIONS:

- A. The voice communications contractor shall have at least five years experience providing similar work, and shall provide a minimum of five references for similar projects completed with the last five years.
- B. The voice communications installer(s) shall be certified category 6A cable installer(s) and shall provide proof of certification.

1.5 SUBMITTALS:

- A. Shop Drawings - In accordance with Section 27 05 00.
- B. Submit the following items:
 - 1. Manufacturer's Catalog Data: Manufacturer's original catalog cuts and original description of data of all material and equipment with sufficient information provided so that the exact function of each device is known.
 - 2. Description of conductors to be used with a statement that all wire shall be in conduit.
 - 3. Floor plan of the point to point connections.

4. Diagram of the wiring circuitry.
 5. Riser diagram.
- C. Single Submittal: A single complete submittal is required for all products covered by this Section.
- D. Closeout Submittals: Submit operation and maintenance data for all components of the telecommunications equipment specified herein. Submit certified test results. Submit in accordance with Division 1.

1.6 WARRANTY:

- A. Manufacturer shall provide a one year warranty for all system components.

PART 2 PRODUCTS

2.1 MODULAR VOICE OUTLETS:

- A. Unless otherwise noted, provide single gang, modular voice outlets.
- B. Voice Jacks must meet the minimum performance specifications for Category 6A of EIA/TIA. All 8-position, modular jack inserts for telephone locations shall comply with EIA/TIA T568B specifications.
1. Modular jacks shall be engraved 'CAT 6A' on the face of the jack insert.
- C. Contractor shall coordinate data wiring scheme (T568B or T568A) with owner.
- D. All components shall be UL listed.
- E. Unless otherwise indicated provide insert and faceplate colors:
1. Single gang wall plate, white with two labels and label covers.
 2. Provide 4 port unless otherwise noted, coordinate number of ports with drawings.
 3. Voice jack, gray.
 4. Blank jack (where applicable), white.
- F. Manufacturer: Ortronics OR-KSFP series or approved equal.

2.2 UTP VOICE WIRE TERMINATION BLOCKS (110 BLOCKS):

- A. Minimum performance specifications: Must meet requirements for Category 6A of EIA/TIA.
- B. Blocks shall be 110 style, mountable in a standard 19-inch equipment rack. Blocks shall comply with EIA/TIA T568B specifications and UL listed. Blocks shall be provided in 100 pair modules. Provide minimum of 20% spare port capacity.
- C. Provide cable management retaining brackets on the back of the panels or other means of securing cables being terminated. Horizontal wire management devices to be placed between each patch panel.
- D. Manufacturer: Leviton 41DBR series or approved equal.

PART 3 EXECUTION

3.1 CABLE & WIRE INSTALLATION:

- A. General:
1. All voice communications cables shall be terminated and tested under this contract.
- B. Station Cables:
1. Install station cabling, outlets and jacks as detailed on the Drawings. The typical configuration for most outlets is two unshielded twisted pair (UTP) cables of 4 pairs each.
 2. Each voice outlet shall be clearly marked with the MDF/IDF, 66 [110] block and circuit to which they are connected.

3.2 QUANTITIES AND LOCATIONS OF ITEMS:

- A. Location and placement of splices, patch panels and other distribution hardware shall be as shown on the Drawings or defined herein. Where Drawings are not specific as to placement, refer below.
- B. Quantities of racks, cabinets, and patch panels, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The contractor is responsible for providing the correct quantities of racks, patch panels, connectors as other equipment necessary to terminate, cross connect and patch the volume of cable described herein and shown on the Drawings.
 - 1. Wall mount 66 blocks, rack mount 110 Blocks installed at locations as noted on the drawings. Complete with all necessary hardware.
 - 2. Blocks for station outlets shall be clearly marked to indicate the room/location served by each port.

3.3 CABLE TERMINATIONS:

- A. UTP cables:
 - 1. Each cable shall be terminated on an 8-pin modular jack as indicated in this specification section. Terminate each cable on an EIA/TIA T568 compliant outlet jack matching the cable's specification.
 - 2. Cable pair twists shall be maintained up to within 0.25 inch of the point of termination. Under no circumstances shall cable pairs be untwisted or otherwise altered prior to termination.

3.4 INSTALLATION OF WALL PLATES:

- A. General - Plates shall match the style of the device and shall be plumb within 1/16-inch of the vertical or horizontal.
- B. Interior Locations, Finished Walls: Install non-metallic plates so that all four edges are in continuous contact with the finished wall surfaces. Plaster filling will not be permitted. Oversized plates or sectional plates are not acceptable and shall not be used. If wall finish will not accommodate proper mounting of the plate, the situation shall be brought to the attention of the architect and the wall finish replaced appropriately.
- C. Interior Locations, Unfinished Walls: Install stainless steel or cast metal cover plates.
- D. Exterior Locations: Install cast metal plates with gaskets on wiring devices in such a manner as to provide a rain tight weatherproof installation. Cover type shall match box type.
- E. Future Locations: Install blanking cover plates on all unused outlets.
- F. Prior to installation, coordinate labeling conventions with owner. Provide typed label(s) for faceplate, indentifying each jack on faceplate, uniquely identifying source and circuit number supplying jack, unless otherwise noted.

3.5 GROUNDING:

- A. Provide dedicated ground at MDF and each IDF. Bond all equipment to ground with insulated ground conductors.

3.6 TESTING:

- A. Paired and Multi-Conductor UTP Cable Testing:
 - 1. After terminating both ends of all UTP cables, but before any cross connects are installed, test all UTP station cables for attenuation and cross-talk (NEXT) to 100 MHz. Test all UTP cables for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
 - 2. After installing cross-connects, perform end-to-end testing of each cross connected cable pair for continuity, ground fault, proper cross-connection, shorts and crossed pairs.

3. For multi-pair cables: For 100 pair or smaller replace entire cable if bad pair is found. For larger pair count cables, replace if more than 1% of pairs are bad.
4. Submit the following information regarding the UTP station cable testing:
 - a. Cable number, cable type, pair or conductor count; individual pair or conductor numbers; number of cross connects and/or patches in each pair; results of each test for each pair or conductor; total number of serviceable pairs or conductors in cable.
 - b. Information required above shall be provided in printed format only.
5. Recommended test equipment (Contractor shall obtain approval of Owner in writing prior to using substitute test equipment):
 - a. Fluke DSP 1100 SR, no known equal. Equipment shall be equipped with latest software. Contractor shall refer to Owner to obtain required set-up parameters.

3.7 ACCEPTANCE:

- A. Upon receipt of the Contractor's documentation of proposed cable testing, the Owner will have the right to review and observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner is totally satisfied, that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

3.8 RECORD DRAWINGS:

- A. The Project record as-built drawings shall show the types and locations of installed:
 1. Station Cables/Outlets.
 2. Main Distribution Frames.
 3. Intermediate Distribution Frames.
 4. 110 Blocks.
- B. The Project record as-built drawings shall identify numbering on each cable identification label.

END OF SECTION

SECTION 27 41 00
AUDIO VISUAL SYSTEMS

PART 1 – GENERAL

1.1 ADDITIONAL INFORMATION

- A. Refer to Section 27 00 00 for the following Part 1 General information
 - 1. References
 - 2. Definitions / Terms / Acronyms
 - 3. Submittal Requirements
 - 4. Contractor Qualifications
 - 5. Manufacturer Qualifications
 - 6. Bidder Qualifications
 - 7. Testing Agency Qualifications
 - 8. Delivery, Storage and Protection
 - 9. Project conditions
 - 10. Sequencing
 - 11. Continuity of Service and Scheduling of Work
 - 12. Protection of Work and Property
 - 13. Warranty
 - a. Products Installed but not Supplied Under This Section
 - 1) Electronic Display Systems (Projectors, LCD panels, Smartboards, etc.) and associated mounting hardware.
 - 2) Video cameras.
 - b. Systems Description
 - 1) Provide a complete infrastructure, wiring, backboxes, devices, and conduit as required to support AV requirements as described herein.
 - 2) Digital Signage:
 - 14. System shall consist of a recessed backbox, data outlets, and digital signage display device.
 - a. Black Box Theater:
 - 15. System shall consist of wireless microphones, hardwired microphones, overhead pendant speakers, a video camera input, video monitor outputs, HDMI extenders, touch panel controls, a digital matrix audio processor, and software-based audio mixing.
 - a. All Other Spaces:
 - 16. Systems shall consist of wireless voicelift microphones, overhead pendant speakers, overhead mounted subwoofer, a video scaling switcher, audio and video inputs, video monitor outputs, HDMI extenders, touch panel controls, digital matrix audio processor, powered amplifier, and control processor.
 - a. Manufacturer Qualifications
 - 1) Manufacturer shall be ISO 9001 certified manufacturer and shall employ Six Sigma methodology in its manufacturing process.
 - 2) Subject to compliance with requirements, provide products of the following:
 - 17. Extron
 - 18. Owner Pre-approved equal
 - a. System Performance
 - 1) See Section 27 10 00 for information on Unshielded Twisted Pair (UTP) Systems

PART 2 – PRODUCTS

2.1 GENERAL

- A. HDMI cords are generally limited to 5 meters or less in length. USB channel total length is limited to 15 feet end to end. When these distances need to be exceeded, the use of an electronic extender is usually required.
- B. Video extenders can be HDMI-only, VGA-only, or DTP/HDBase-T. DTP/HDBase-T can provide up to 5 different signal types on one CAT6A cable between the transmitter and receiver. These signal types are:
 - 1. Audio
 - 2. Video
 - 3. Power
 - 4. Signalling
 - 5. Ethernet
 - a. The goal of the Audio-Visual system is to balance simplicity with functionality to achieve maximum performance in any given situation.

2.2 HDMI TRANSMITTER – DECORA STYLE:

- A. Provide an HDMI decorator-style wallplate twisted pair transmitter that shall support the distribution of video, audio, and control over a shielded CATx cable
 - 1. Single-gang decorator-style wallplate transmitter for the transmission of HDMI, audio, and control
 - 2. Video input requirements
 - a. Provide one (1) video input for digital video signals
 - 1) Supported HDMI specifications include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
 - 3. Audio input requirements
 - a. Support embedded digital audio on HDMI input
 - b. Provide a dedicated analog audio input connection
 - 1) One (1) stereo analog audio
 - 4. Control input requirements
 - a. Provide communication connections for AV device control
 - 1) One bidirectional RS-232 pass-through
 - 2) One bidirectional IR pass-through
 - 5. Interconnection requirements
 - a. Support interconnection between transmitter and receiver or DTP®-enabled products
 - 1) One RJ-45 twisted pair connection
 - b. Shall be configurable for sending digital video and embedded audio, plus bidirectional RS-232 and IR signals to an HDBaseT-enabled display
 - 6. Transmission requirements
 - a. Provide signal transmission distance capability of 230 feet (70 m) at 1920x1200, including 1080p @ 60 Hz and 2K using a shielded CATx cable
 - b. Support signal transmission distance capability of 4K @ 30 Hz, UHD, and 2560x1600 up to 130 feet (40 m) using a shielded CATx cable
 - c. Support video, audio, and control over a single shielded CATx cable
 - d. Support embedded HD lossless audio formats
 - e. Actively buffer DDC channels
 - 7. Resolution requirements
 - a. Support computer and video resolutions up to 4K, including 1080p/60 Deep Color
 - b. Support RGB and YCbCr digital video formats
 - 8. Audio requirements

- a. The unit shall accept additional analog stereo audio signals for simultaneous transmission with HDMI embedded audio
- b. The unit shall support multiple embedded audio formats
- c. The unit shall support embedded HD lossless audio formats
9. HDCP requirements
 - a. The unit shall be HDCP 2.3 compliant with backward compatibility with earlier HDCP versions
10. Communication requirements
 - a. The unit shall support bidirectional RS-232 communication pass-through up to 115200 baud
 - b. The unit shall support bidirectional IR pass-through
 - c. The unit shall support EDID and HDCP transmission
11. Power requirements
 - a. The unit shall support remote power capability
 - b. The unit shall support being locally powered
12. General Requirements
 - a. The unit shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - b. The unit shall support HDMI specifications including data rates up to 10.2 Gbps, Deep Color, 3D, HD lossless audio formats, and CEC pass-through
 - c. The unit shall support being locally or remotely powered
 - d. The unit shall support embedded HD lossless audio formats
 - e. The unit shall support the use of HDMI to DVI-D cables or adapters for DVI-D
 - f. The unit shall support installation into standard US one-gang electrical junction boxes
 - g. Shall provide visual indication of signal presence and power
 - h. Shall meet regulatory compliances
 - 1) CE, c-UL, UL
 - 2) CE, C-tick, FCC Class A, ICES, VCCI
 - i. Shall provide at least 3 years parts and labor warranty
 - j. Shall be compatible with other DTP-enabled products
13. Approved device shall be the Extron DTP T HWP 4K 231 D (60-1421-12 or 60-1421-13); no alternates or equals

2.3 HDMI RECIEVER - RACK MOUNTED

- A. Provide an HDMI twisted pair receiver that shall support the distribution of video, audio, and control over a shielded CATx cable
 1. Rack-mountable receiver for HDMI, audio, and control
 2. Video output requirements
 - a. Provide one (1) video output for digital video signals
 - 1) Supported HDMI specifications include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
 3. Audio output requirements
 - a. Support embedded digital audio on HDMI output
 - b. Provide a dedicated analog audio output connection
 - 1) One (1) stereo analog audio
 4. Control output requirements
 - a. Provide communication connections for AV device control
 - 1) One bidirectional RS-232 pass-through
 - 2) One bidirectional IR pass-through
 5. Interconnection requirements
 - a. Support interconnection between receiver and transmitter or DTP®-enabled products

- 1) One RJ-45 twisted pair connection
 6. Transmission requirements
 - a. Provide signal transmission distance capability of 230 feet (70 m) at 1920x1200, including 1080p @ 60 Hz and 2K using a shielded CATx cable
 - b. Support signal transmission distance capability of 4K @ 30 Hz, UHD, and 2560x1600 up to 130 feet (40 m) using a shielded CATx cable
 - c. Support video, audio, and control over a single shielded CATx cable
 - d. Support embedded HD lossless audio formats
 - e. Actively buffer DDC channels
 7. Resolution requirements
 - a. Support computer and video resolutions up to 4K, including 1080p/60 Deep Color
 - b. Support RGB and YCbCr digital video formats
 8. Audio requirements
 - a. The unit shall support analog stereo audio pass-through signals
 - b. The unit shall support multiple embedded audio formats
 - c. The unit shall support embedded HD lossless audio formats
 9. HDCP requirements
 - a. The unit shall be HDCP 2.3 compliant with backward compatibility with earlier HDCP versions
 10. Communication requirements
 - a. The unit shall support bidirectional RS-232 communication pass-through up to 115200 baud
 - b. The unit shall support bidirectional IR pass-through
 - c. The unit shall support EDID and HDCP transmission
 11. Power requirements
 - a. The unit shall support remote power capability
 - b. The unit shall support being locally powered
 12. General requirements
 - a. The unit shall be HDCP 2.3 compliant with backward compatibility with earlier HDCP versions
 - b. The unit shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - c. The unit shall support HDMI specifications including data rates up to 10.2 Gbps, Deep Color, 3D, HD lossless audio formats, and CEC pass-through
 - d. The unit shall support being locally or remotely powered
 - e. The unit shall support embedded HD lossless audio formats
 - f. The unit shall support the use of HDMI to DVI-D cables or adapters for DVI-D
 - g. The unit shall have a low profile enclosure and versatile mounting capability
 - h. Shall provide visual indication for signal presence and power
 - i. Shall meet regulatory compliances
 - 1) CE, c-UL, UL
 - 2) CE, C-tick, FCC Class A, ICES, VCCI
 - j. Shall provide at least 3 years parts and labor warranty
 - k. Shall be compatible with other DTP-enabled products
 - B. Approved device shall be the Extron DTP HDMI 4K 230 Rx (60-1271-13); no alternates or equals
- 2.4 DIGITAL MATRIX PROCESSOR:
- A. Provide an audio digital matrix processor that shall support 12 mono analog inputs capable of microphone or line level signals and 8 mono analog line level outputs for signal routing and

management.

1. 12 input, 8 output audio digital matrix processor with digital audio expansion port, automixer function with eight groups, 64-bit floating point DSP engine, four input / four output USB audio interface, macros, 8x4 configurable aux inputs / outputs, 16 virtual processing loops, up to eight audio file players, ACP audio control panel support, and 24-bit/48 kHz audio converters
 - a. Input Requirements
 - 1) Shall support twelve mono analog inputs that accepts 3.5 mm captive screw connectors:
 - (a) Microphone level
 - (b) Line level, balanced or unbalanced
 - 2) Shall provide input gain adjustment from -18 dB to +80 dB in 0.1 dB steps, adjustable per input
 - 3) Shall provide selectable +48 volt phantom power for condenser microphones on first eight inputs
 - 4) Shall provide analog to digital conversion at 48 kHz sampling rate with 24-bit resolution
 - b. Output Requirements
 - 1) Shall support eight mono line level, balanced or unbalanced outputs that accept 3.5 mm captive screw connectors
 - 2) Shall provide output attenuation adjustment from 0 dB to -100 dB in 0.1 dB steps, adjustable per output
 - 3) Shall provide digital to analog conversion at 48 kHz sampling rate with 24-bit resolution
 - c. DSP Engine Requirements
 - 1) Shall provide 64-bit floating point DSP engine
 - 2) Shall provide a 52x44 mix matrix such that all inputs and returns can be discretely routed to any or all of the outputs or sends
 - 3) Shall provide a maximum, deterministic latency of 3.2 ms from input to output
 - 4) Shall provide additional, deterministic latency of 1.3 ms when Virtual Path routing is used
 - d. Audio Device Requirements — Input to Output
 - 1) Shall provide an analog in to analog out signal-to-noise ratio of greater than 107 dB measured from 20 Hz to 20 kHz, at maximum balanced output, unweighted
 - 2) Shall provide a THD+N measurement of less than 0.01% measured at 20 Hz to 20 kHz, at maximum level
 - e. Configuration Software Requirements
 - 1) Shall provide PC-based DSP Configurator software allowing flexible control of the digital signal processor's fixed architecture
 - 2) Shall provide a Live mode for real-time control of parameters without compiling and file uploading to processor
 - 3) Shall provide an Emulate mode for offline configuration
 - 4) Shall provide single, scrollable window for viewing of all inputs and outputs, audio processing blocks, routing, mix points, and virtual routing
 - 5) Shall provide setup and configuration of digital audio processing tools including, but not limited to: Filters (high pass, low pass, bass shelving, treble shelving, parametric, dynamic loudness, and notch EQ); Dynamics processing (AGC, Compressor, Limiter, Noise Gate); Delay processing; Ducking and Adaptive Gain processing; Feedback Suppressor processing, Automixing; and multiple gain stages
 - 6) Shall provide cut, copy, paste editing between processing blocks

- 7) Shall provide matrix routing with integrated mix point gain adjustment between inputs, outputs, aux inputs, aux outputs, virtual sends, virtual returns, expansion inputs, and expansion outputs
 - 8) Shall provide a library of pre-designed processor settings for inputs and outputs with user-customizable parameters
 - 9) Shall provide Group Master controls for consolidation of individual gain or mute control members of the same type into one point of control
 - 10) Shall provide Soft Limits settings to define upper and lower control limits on Group Masters for use with external controls
 - 11) Shall provide Presets for recall of any processing block setting, level setting or audio routing; presets shall be saved for the entire system, or any selected partial group of inputs, outputs, mix points, and DSP blocks
 - 12) Shall provide real-time metering of levels within each Input Gain, AGC, Compressor, Limiter, Noise Gate, Automixer, and Output Attenuation processing block in Live mode
 - 13) Shall provide a Meter Bridge window for real-time metering of all input and output channels with clipping indication in Live mode
 - 14) Shall provide keyboard-based navigation of configuration software utilizing directional controls, keyboard shortcuts, and spreadsheet software-style commands
 - 15) Shall provide file saving in both Live and Emulate mode
 - 16) Shall provide file upload in Live mode
 - 17) Shall provide configuration and file saving of multiple, linked or networked processors from a single configuration software session
- f. Aux Input/Output Requirements
- 1) Shall provide a total of 8 Aux Inputs to be configured with a combination of file players and USB audio connections.
 - 2) Shall provide a total of 4 Aux Outputs, assignable to USB audio connections.
- g. Expansion Port Requirements
- 1) Shall provide digital audio expansion port for bidirectional signal routing between two connected processors at sub-millisecond latency
 - 2) Shall support 16 incoming signals and 16 outgoing signals
 - 3) Shall provide uncompressed digital audio at 48 kHz sampling rate with 24-bit resolution
 - 4) Product shall include as standard, 1 foot (0.3 m) shielded CAT 6 cable for the purposes of interconnecting two units
- h. Automixer Requirements
- 1) Shall provide Automixer Group selection for optional channel assignment into any of eight groups
 - 2) Shall provide gated and gain sharing automixer types
 - 3) Shall provide Last Open Mic Priority and Chairman Priority modes
 - 4) Shall provide Max Number of Open Microphone parameter from 1 to 12 microphones
 - 5) Shall provide Gate Threshold level and adjustable Off Reduction level for gated channels
 - 6) Shall provide adjustable parameters for Attack, Hold, and Release times
 - 7) Shall provide real-time metering of Signal Level, Gate Status, and Gate Threshold target from within the Automix parameter setup window
 - 8) Shall provide global view with Gate Status indication of all channels assigned to an automixer group
- i. Control Requirements

- 1) Shall accept an RJ-45 connector to provide Ethernet monitoring and control using standard TCP/IP protocols to support real-time monitoring and system management over a LAN or WAN
 - 2) Shall accept 3.5 mm captive screw connectors to support bidirectional RS-232
 - 3) Shall provide an ACP audio control port to support the use of Extron Audio Control Panels.
 - 4) Shall provide a female USB mini type B port for software control
 - 5) Shall support remote control operation via external control system using Simple Instruction Set commands sent over RS-232, Ethernet, or USB
 - 6) Shall provide 8 sets of 3 configurable digital I/O ports that accept 3.5 mm captive screw connectors and can be programmed to sense and then respond to external triggers
- j. Front Panel Requirements
- 1) Shall provide a green LED for power indication
 - 2) Shall provide Configuration port that accepts a USB mini type B connector
 - 3) Shall provide green LEDs for Expansion port, LAN port, and USB audio interface activity indication
 - 4) Shall provide green LEDs for input and output signal presence indication
 - 5) Shall provide red LEDs for input and output clip warning indication
- k. Rear Panel Requirements
- 1) Shall provide 12 inputs that accept 3.5 mm captive screw connectors
 - 2) Shall provide 8 outputs that accept 3.5 mm captive screw connectors
 - 3) Shall provide a 4x4 digital audio interface on a mini USB B port
 - 4) Shall provide 8 digital input and 16 digital output ports that accept 3.5 mm captive screw connectors
 - 5) Shall provide bidirectional RS-232 port that accepts 3.5 mm captive screw connector
 - 6) Shall provide Expansion port that accepts an RJ-45 connector
 - 7) Shall provide Ethernet host port that accepts an RJ-45 connector
 - 8) Shall provide an ACP audio control port that accepts a 3.5 mm captive screw connector
- l. General Requirements
- 1) Shall provide internal universal power supply with IEC power socket and support for international 100-240 VAC, 50/60 Hz standards
 - 2) Shall be enclosed in a rack-mountable 1U, full rack width metal enclosure
 - 3) Shall be convection-cooled
 - 4) Shall meet regulatory compliances
 - (a) Shall meet safety compliances under CE, c-UL, and UL
 - (b) Shall meet EMI/EMC compliances under CE, C-tick, FCC Class A, ICES, and VCCI
 - (c) Shall comply with appropriate requirements of RoHS and WEEE
 - 5) Shall provide three year parts and labor warranty
- B. Approved device shall be the Extron DMP 128 Plus, part number 60-1511-01; no alternates or equals.

2.5 HDMI TRANSMITTER WITH LOOP-THROUGH - RACK MOUNTED:

- A. Provide an HDMI twisted pair transmitter that shall include input loop-through and support the long distance distribution of video and control over a shielded CATx cable
1. Rack-mountable transmitter for the transmission of HDMI with embedded audio, and control
 2. Video input requirements

- a. Provide one (1) video input for digital video signals
 - 1) Supported HDMI specifications include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, and HD lossless audio formats
 - b. Provide automatic cable equalization for the digital input to 100 feet (30 meters) at 1920x1200 with 8-bit color when used with Extron HDMI Pro cables
 - c. Provide automatic cable equalization for the digital input to 50 feet (15 meters) at 4K/30 and 2560x1600 @ 60 Hz resolutions when used with Extron HDMI Pro cables
3. Audio input requirements
 - a. Support embedded digital audio on HDMI input
 4. Control input requirements
 - a. Provide communication connections for AV device control
 - 1) One bidirectional RS-232 pass-through
 - 2) One bidirectional IR pass-through
 5. Video output requirements
 - a. Provide one (1) HDMI for buffered input loop-through for local monitor support or system expansion
 - b. Support the connection of DVI displays that do not recognize HDMI-specific formats
 - 1) Automatically enable or disable embedded TMDS audio and InfoFrames
 - 2) Automatically set the correct color space
 - c. Provide +5 VDC, 250 mA power on local HDMI output
 6. Interconnection requirements
 - a. Support interconnection between transmitter and receiver or DTP®-enabled products
 - 1) One RJ-45 twisted pair connection
 - b. Shall be configurable for sending digital video and embedded audio, plus bidirectional RS-232 and IR signals to an HDBaseT-enabled display
 7. Transmission requirements
 - a. Provide signal transmission distance capability of 330 feet (100 m) for supported resolutions, including 4K, UHD, 2560x1600, and 1080p @ 60 Hz using a shielded CATx cable
 - b. Support video, audio, and control over shielded CATx cable
 - c. Support embedded HD lossless audio formats
 - d. Actively buffer DDC channels
 8. Resolution requirements
 - a. Support computer and video resolutions up to 4K, including 1080p/60 Deep Color
 - b. Support RGB and YCbCr digital video formats
 9. Audio requirements
 - a. The unit shall support multiple embedded audio formats
 - b. The unit shall support embedded HD lossless audio formats
 10. EDID requirements
 - a. Provide automatic EDID management between connected devices
 - 1) Shall provide user-selection of EDID from any connected display
 - 2) Shall provide user-selection of EDID from pre-stored data files
 - 3) Shall maintain continuous EDID communication with the connected source
 11. HDCP requirements
 - a. The unit shall be HDCP compliant
 - 1) Provide authentication and maintain continuous verification of HDCP key exchange with connected sink devices
 - 2) Provide authentication and maintain continuous verification of HDCP key exchange with the connected source device

- b. Shall provide the option to disable HDCP processing at the HDMI input connection when passing unencrypted content
 - c. Provide real-time verification of HDCP status for each HDMI input and output
 - 1) Accessible through front panel LEDs
 - 2) Electronically accessible over USB connection
 - 12. Communication requirements
 - a. The unit shall support bidirectional RS-232 communication pass-through up to 115200 baud
 - b. The unit shall support bidirectional IR pass-through
 - c. The unit shall support EDID and HDCP transmission
 - 13. Power requirements
 - a. The unit shall support remote power capability
 - b. The unit shall support being locally powered
 - 14. Control/Configuration requirements
 - a. Shall support product configuration/setup through a product configuration software application connected via USB
 - 15. General requirements
 - a. The unit shall be HDCP compliant
 - b. The unit shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - c. The unit shall support HDMI specifications including data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, and HD lossless audio formats
 - d. The unit shall support being locally or remotely powered
 - e. The unit shall support embedded HD lossless audio formats
 - f. The unit shall support the use of HDMI to DVI-D cables or adapters for DVI-D signals
 - g. The unit shall have a low profile enclosure and versatile mounting capability
 - h. Shall provide visual indication for signal presence and power
 - i. Shall meet regulator compliances
 - 1) CE, c-UL, UL
 - 2) CE, C-tick, FCC Class A, ICES, VCCI
 - j. Shall provide at least 3 years parts and labor warranty
 - k. Shall be compatible with other DTP-enabled products
- B. Approved device shall be the Extron DTP T HD2 4K 330 (60-1491-52); no alternates or equals
- 2.6 HDMI DECORA STYLE RECEIVER - WALL MOUNTED:
- A. Provide an HDMI decorator-style wallplate twisted pair receiver that shall support the long distance distribution of video, audio, and control over a shielded CATx cable
 - 1. Single-gang decorator-style wallplate receiver for HDMI, audio, and control
 - 2. Video output requirements
 - a. Provide one (1) video output for digital video signals
 - 1) Supported HDMI specifications include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
 - 3. Audio output requirements
 - a. Support embedded digital audio on HDMI output
 - b. Provide a dedicated analog audio output connection
 - 1) One (1) stereo analog audio
 - 4. Control output requirements
 - a. Provide communication connections for AV device control
 - 1) One bidirectional RS-232 pass-through

- 2) One bidirectional IR pass-through
 5. Interconnection requirements
 - a. Support interconnection between receiver and transmitter or DTP®-enabled products
 - 1) One RJ-45 twisted pair connection
 6. Transmission requirements
 - a. Provide signal transmission distance capability of 330 feet (100 m) for supported resolutions, including 4K, UHD, 2560x1600, and 1080p @ 60 Hz using a shielded CATx cable
 - b. Support video, audio, and control over a single shielded CATx cable
 - c. Support embedded HD lossless audio formats
 - d. Actively buffer DDC channels
 7. Resolution requirements
 - a. Support computer and video resolutions up to 4K, including 1080p/60 Deep Color
 - b. Support RGB and YCbCr digital video formats
 8. Audio requirements
 - a. The unit shall support analog stereo audio pass-through signals
 - b. The unit shall support multiple embedded audio formats
 - c. The unit shall support embedded HD lossless audio formats
 9. HDCP requirements
 - a. The unit shall be HDCP 2.3 compliant with backward compatibility with earlier HDCP versions
 10. Communication requirements
 - a. The unit shall support bidirectional RS-232 communication pass-through up to 115200 baud
 - b. The unit shall support bidirectional IR pass-through
 - c. The unit shall support EDID and HDCP transmission
 11. Power requirements
 - a. The unit shall support remote power capability
 - b. The unit shall support being locally powered
 12. General requirements
 - a. The unit shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - b. The unit shall support HDMI specifications including data rates up to 10.2 Gbps, Deep Color, 3D, HD lossless audio formats, and CEC pass-through
 - c. The unit shall support being locally or remotely powered
 - d. The unit shall support embedded HD lossless audio formats
 - e. The unit shall support the use of HDMI to DVI-D cables or adapters for DVI-D
 - f. The unit shall support installation into standard US one-gang electrical junction boxes
 - g. Shall provide visual indication of signal presence and power
 - h. Shall meet regulatory compliances
 - 1) CE, c-UL, UL
 - 2) CE, C-tick, FCC Class A, ICES, VCCI
 - i. Shall provide at least 3 years parts and labor warranty
 - j. Shall be compatible with other DTP-enabled products
- B. Approved device shall be the Extron DTP R HWP 4K 331 D (60-1531-52 or 60-1531-53); no alternates or equals

2.7 HDMI RECEIVER - RACK MOUNTED:

- A. Provide an HDMI twisted pair receiver that shall support the long distance distribution of video, audio, and control over a shielded CATx cable

1. Rack-mountable receiver for HDMI, audio, and control
2. Video output requirements
 - a. Provide one (1) video output for digital video signals
 - 1) Supported HDMI specifications include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
3. Audio output requirements
 - a. Support embedded digital audio on HDMI output
 - b. Provide a dedicated analog audio output connection
 - 1) One (1) stereo analog audio
4. Control output requirements
 - a. Provide communication connections for AV device control
 - 1) One bidirectional RS-232 pass-through
 - 2) One bidirectional IR pass-through
5. Interconnection requirements
 - a. Support interconnection between receiver and transmitter or DTP®-enabled products
 - 1) One RJ-45 twisted pair connection
6. Transmission requirements
 - a. Provide signal transmission distance capability up to 330 feet (100 m) for supported resolutions, including 4K, UHD, 2560x1600, and 1080p @ 60 Hz using a shielded CATx cable
 - b. Support video, audio, and control over a single shielded CATx cable
 - c. Support embedded HD lossless audio formats
 - d. Actively buffer DDC channels
7. Resolution requirements
 - a. Support computer and video resolutions up to 4K, including 1080p/60 Deep Color
 - b. Support RGB and YCbCr digital video formats
8. Audio requirements
 - a. The unit shall support analog stereo audio pass-through signals
 - b. The unit shall support multiple embedded audio formats
 - c. The unit shall support embedded HD lossless audio formats
9. HDCP requirements
 - a. The unit shall be HDCP 2.3 compliant with backward compatibility with earlier HDCP versions
10. Communication requirements
 - a. The unit shall support bidirectional RS-232 communication pass-through up to 115200 baud
 - b. The unit shall support bidirectional IR pass-through
 - c. The unit shall support EDID and HDCP transmission
11. Power requirements
 - a. The unit shall support remote power capability
 - b. The unit shall support being locally powered
12. General requirements
 - a. The unit shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - b. The unit shall support HDMI specifications including data rates up to 10.2 Gbps, Deep Color, 3D, HD lossless audio formats, and CEC pass-through
 - c. The unit shall support being locally or remotely powered
 - d. The unit shall support embedded HD lossless audio formats
 - e. The unit shall support the use of HDMI to DVI-D cables or adapters for DVI-D
 - f. The unit shall have a low profile enclosure and versatile mounting capability

- g. Shall provide visual indication for signal presence and power
 - h. Shall meet regulatory compliances
 - 1) CE, c-UL, UL
 - 2) CE, C-tick, FCC Class A, ICES, VCCI
 - i. Shall provide at least 3 years parts and labor warranty
 - j. Shall be compatible with other DTP-enabled products
- B. Approved device shall be the Extron DTP HDMI 4K 330 Rx (60-1331-13); no alternates or equals

2.8 HDMI TRANSMITTER - RACK MOUNTED:

- A. Provide an HDMI twisted pair transmitter that shall support the distribution of video, audio, and control over a shielded CATx cable
- 1. Rack-mountable transmitter for the transmission of HDMI, audio, and control
 - 2. Video input requirements
 - a. Provide one (1) video input for digital video signals
 - b. Supported HDMI specifications include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
 - 3. Audio input requirements
 - a. Support embedded digital audio on HDMI input
 - b. Provide a dedicated analog audio input connection
 - 1) One (1) stereo analog audio
 - 4. Control input requirements
 - a. Provide communication connections for AV device control
 - 1) One bidirectional RS-232 pass-through
 - 2) One bidirectional IR pass-through
 - 5. Interconnection requirements
 - a. Support interconnection between transmitter and receiver or DTP®-enabled products
 - 1) One RJ-45 twisted pair connection
 - 6. Transmission requirements
 - a. Provide signal transmission distance capability of 230 feet (70 m) at 1920x1200, including 1080p @ 60 Hz and 2K using a shielded CATx cable
 - b. Support signal transmission distance capability of 4K @ 30 Hz, UHD, and 2560x1600 up to 130 feet (40 m) using a shielded CATx cable
 - c. Support video, audio, and control over a single shielded CATx cable
 - d. Support embedded HD lossless audio formats
 - e. Actively buffer DDC channels
 - 7. Resolution requirements
 - a. Support computer and video resolutions up to 4K, including 1080p/60 Deep Color
 - b. Support RGB and YCbCr digital video formats
 - 8. Audio requirements
 - a. The unit shall accept additional analog stereo audio signals for simultaneous transmission with HDMI embedded audio
 - b. The unit shall support multiple embedded audio formats
 - c. The unit shall support embedded HD lossless audio formats
 - 9. HDCP requirements
 - a. The unit shall be HDCP 2.3 compliant with backward compatibility with earlier HDCP versions
 - 10. Communication requirements
 - a. The unit shall support bidirectional RS-232 communication pass-through up to 115200 baud

- b. The unit shall support bidirectional IR pass-through
 - c. The unit shall support EDID and HDCP transmission
 - 11. Power requirements
 - a. The unit shall support remote power capability
 - 12. The unit shall support being locally powered
 - 13. General requirements
 - a. The unit shall be HDCP 2.3 compliant with backward compatibility with earlier HDCP versions
 - b. The unit shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - c. The unit shall support HDMI specifications including data rates up to 10.2 Gbps, Deep Color, 3D, HD lossless audio formats, and CEC pass-through
 - d. The unit shall support being locally or remotely powered
 - e. The unit shall support embedded HD lossless audio formats
 - f. The unit shall support the use of HDMI to DVI-D cables or adapters for DVI-D
 - g. The unit shall have a low profile enclosure and versatile mounting capability
 - h. Shall provide visual indication for signal presence and power
 - i. Shall meet regulatory compliances
 - 1) CE, c-UL, UL
 - 2) CE, C-tick, FCC Class A, ICES, VCCI
 - j. Shall provide at least 3 years parts and labor warranty
 - k. Shall be compatible with other DTP-enabled products
 - B. Approved device shall be the Extron DTP HDMI 4K 230 Tx (60-1271-12); no alternates or equals
- 2.9 HDMI TRANSMITTER - RACK MOUNTED:
- A. Provide an HDMI twisted pair transmitter that shall support the long distance distribution of video, audio, and control over a shielded CATx cable
 - 1. Rack-mountable transmitter for the transmission of HDMI, audio, and control
 - 2. Video input requirements
 - a. Provide one (1) video input for digital video signals
 - 1) Supported HDMI specifications include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
 - 3. Audio input requirements
 - a. Support embedded digital audio on HDMI input
 - b. Provide a dedicated analog audio input connection
 - c. One (1) stereo analog audio
 - 4. Control input requirements
 - a. Provide communication connections for AV device control
 - 1) One bidirectional RS-232 pass-through
 - 2) One bidirectional IR pass-through
 - 5. Interconnection requirements
 - a. Support interconnection between transmitter and receiver or DTP®-enabled products
 - 1) One RJ-45 twisted pair connection
 - 6. Transmission requirements
 - a. Provide signal transmission distance capability up to 330 feet (100 m) for supported resolutions, including 4K, UHD, 2560x1600, and 1080p @ 60 Hz using a shielded CATx cable
 - b. Support video, audio, and control over a single shielded CATx cable
 - c. Support embedded HD lossless audio formats

- d. Actively buffer DDC channels
 - 7. Resolution requirements
 - a. Support computer and video resolutions up to 4K, including 1080p/60 Deep Color
 - b. Support RGB and YCbCr digital video formats
 - 8. Audio requirements
 - a. The unit shall accept additional analog stereo audio signals for simultaneous transmission with HDMI embedded audio
 - b. The unit shall support multiple embedded audio formats
 - c. The unit shall support embedded HD lossless audio formats
 - 9. HDCP requirements
 - a. The unit shall be HDCP 2.3 compliant with backward compatibility with earlier HDCP versions
 - 10. Communication requirements
 - a. The unit shall support bidirectional RS-232 communication pass-through up to 115200 baud
 - b. The unit shall support bidirectional IR pass-through
 - c. The unit shall support EDID and HDCP transmission
 - 11. Power requirements
 - a. The unit shall support remote power capability
 - b. The unit shall support being locally powered
 - 12. General requirements
 - a. The unit shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - b. The unit shall support HDMI specifications including data rates up to 10.2 Gbps, Deep Color, 3D, HD lossless audio formats, and CEC pass-through
 - c. The unit shall support being locally or remotely powered
 - d. The unit shall support embedded HD lossless audio formats
 - e. The unit shall support the use of HDMI to DVI-D cables or adapters for DVI-D
 - f. The unit shall have a low profile enclosure and versatile mounting capability
 - g. Shall provide visual indication for signal presence and power
 - h. Shall meet regulatory compliances
 - 1) CE, c-UL, UL
 - 2) CE, C-tick, FCC Class A, ICES, VCCI
 - i. Shall provide at least 3 years parts and labor warranty
 - j. Shall be compatible with other DTP-enabled products
- B. Approved device shall be the Extron DTP HDMI 4K 330 Tx (60-1331-12); no alternates or equals

2.10 POWER INJECTOR

- A. Provide a single port power injector that is compatible with XTP Systems transmitters and receivers.
 - 1. Single port power injector that provides power to one (1) remote device in order to eliminate the need for a local power supply
 - a. Provide two (2) RJ-45 style jacks
 - 1) One (1) XTP signal input
 - 2) One (1) XTP loop-through with power
 - b. Supports high data rate of XTP System devices
 - c. Provides integrated mounting solution
 - 2. Approved device shall be the Extron XTP PI 100 (60-1233-01); no alternates or equals

2.11 VIDEO SCALER:

- A. Provide a video scaling presentation switcher that shall support up to four inputs and two simultaneous outputs for processing and switching of DisplayPort and HDMI video sources, with additional support for signal extension over shielded CATx cable
 - 1. Rack-mountable scaler and switcher for DisplayPort and HDMI video sources and associated digital and analog audio
 - 2. Video Input Requirements
 - a. Provide video input connections
 - 1) One (1) DisplayPort supporting DisplayPort SST - Single Stream Transport data rates up to 21.6 Gbps
 - 2) Two (3) HDMI supporting HDMI specifications including 4K/60 Deep Color, data rates up to 18 Gbps, and HD lossless audio formats
 - 3) One (1) RJ-45 for DTP2 twisted pair
 - b. Provide automatic detection of input video parameters
 - 1) Determine total pixels, active pixels, active lines, H/V starting points, H/V image positions, H/V image sizes, and video clock phase
 - 2) The user may selectively enable to disable automatic detection for each input
 - c. Provide image adjustments for brightness, contrast, color, tint, detail, H/V positioning, and sizing
 - d. Provide storage and recall of video parameters and picture settings
 - 1) Automatic memories for each video input
 - (a) Save video settings and picture adjustments without user intervention
 - (b) Automatically recall settings when the same video rate is encountered
 - (c) The user may selectively enable or disable automatic memories
 - 2) Manual user presets
 - (a) Save picture adjustments
 - (b) User presets may be saved and recalled using front panel controls
 - (c) User presets may be saved and recalled electronically via Ethernet, RS-232 or USB connection
 - 3) Manual input presets
 - (a) Save video settings and picture adjustments
 - (b) Input presets may be saved and recalled electronically via Ethernet, RS-232 or USB connection
 - e. Provide automatic 3:2 and 2:2 pulldown detection
 - 3. Video Output Requirements
 - a. Provide video output connections
 - 1) One (1) HDMI
 - 2) One (1) RJ-45 for DTP2 twisted pair
 - b. Provide a range of selectable video output rates from 640x480 to 4096x2160 @ 60 Hz
 - c. Support custom user-defined output resolutions via EDID management
 - d. Provide image scaling and video format conversion with 30-bit precision and 4:4:4 chroma sampling
 - e. Provide motion adaptive deinterlacing for signals up to 1080i
 - f. Provide aspect ratio control
 - 1) When in FILL mode, the video image shall always fill the output screen without letterbox or pillarbox
 - 2) When in FOLLOW mode, the video image on the output screen shall always preserve the aspect ratio of the input signals without distortion
 - g. Provide internal test patterns for calibration and setup

- h. Support image freeze via Ethernet, RS-232 or USB connection
 - i. Support upload and placement of a custom logo graphic at any position on the video output
 - 1) Support logo placement as a foreground image
 - 2) Shall support uploading logo graphics in BMP, JPG, PNG, GIF, or TIFF format
 - 3) Shall support displaying full screen images up to 4096x2160 resolution
 - 4) Shall support up to 16 logo presets
 - 5) Shall support keying with selectable effects including transparency, color key, level key, and alpha key
 - j. Support automatic muting of video and sync output when no video input signal is present
 - 1) Provide a choice to generate a blue screen or a black screen before disabling sync
 - 2) Provide a configurable timeout period before disabling sync
 - 3) The user may selectively enable or disable automatic muting of sync output
 - k. Provide a low power standby state selectable via Ethernet, RS-232 or USB
 - l. Support the connection of DVI displays that do not recognize HDMI-specific formats
 - 1) Automatically enable or disable embedded TMDS audio and InfoFrames
 - 2) Automatically set the correct color space
 - m. Support selection of output color space as RGB or component video
4. Switching Requirements
- a. Provide configurable automatic switching modes between input sources
 - 1) Last connected: always switch to the last active connected input
 - 2) Configurable priority: switching priority may be assigned arbitrarily for any combination of the four inputs
 - b. Provide selectable transition effects when switching inputs
 - 1) Seamless Cut: video output shall freeze, then cut to the newly selected input source
 - 2) Seamless Fade: video output shall freeze, then fade into the newly selected input source
 - 3) Cut through black: video output shall cut to black, then cut to the newly selected input source
 - 4) Fade through black: video output shall fade to black, then fade into the newly selected input source
 - 5) Accompanying audio shall ramp down, then ramp up to match the transition effect
5. EDID Requirements
- a. Provide automatic EDID management between connected devices
 - 1) Provide a set of pre-stored EDID files
 - 2) Support capture of EDID from any connected display
 - 3) Support user uploading of custom-generated EDID files
 - 4) Support assignment of any pre-stored, captured, or custom uploaded EDID file to any input connection
6. HDCP Requirements
- a. The unit shall be HDCP 2.3 compliant
 - 1) Provide authentication and maintain continuous verification of HDCP key exchange with connected sink devices
 - 2) Provide authentication and maintain continuous verification of HDCP key exchange with connected source devices
 - 3) Provide the option to disable HDCP processing at video inputs 2 through 4 when passing unencrypted content

- 4) Provide selectable, human-readable visual confirmation of HDCP compliance when encrypted content is routed to a non-HDCP compliant display
 - (a) When enabled, the video output shall be a solid green color and an on-screen message stating “HDCP CONTENT” shall be displayed
 - (b) When enabled, the option shall be provided to display a user-provided image in place of the green video output
 - (c) When disabled, the output shall be muted
 - b. Provide real-time verification of HDCP status for each video input and output
 - 1) Directly readable on front panel LEDs
 - 2) Electronically accessible over Ethernet, RS-232 or USB connection
7. DTP2 Twisted pair requirements
 - a. Provide signal transmission distance capability of 330 feet (100 meters) for all supported video resolutions using a shielded CATx cable
 - b. Support video, audio, RS-232, IR, and power transmission over a single shielded CATx cable
 - c. Shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - d. Support computer and video resolutions up to 3840x2160/60 at 4:4:4 chroma sampling
 - e. Support stereo audio pass-through signals
 - f. Shall actively buffer DDC channels
 - g. Shall be configurable for compatibility with
 - 1) Extron DTP inputs and outputs
 - 2) Extron DTP2 inputs and outputs
 - 3) Extron XTP matrix switcher inputs and outputs
 - 4) HDBaseT inputs
 - h. Provide power to remote DTP or DTP2 endpoint connected over the shielded CATx cable.
8. Audio Requirements
 - a. Provide audio input connections
 - 1) One (1) DisplayPort, embedded
 - 2) Two (2) HDMI, embedded
 - 3) One RJ-45 for DTP2 twisted pair transmitting both:
 - (a) Embedded digital audio
 - (b) Pass-through stereo audio
 - 4) One (1) 5-pole 3.5mm captive screw, balanced/unbalanced line level analog stereo
 - b. Provide audio output connections
 - 1) One (1) 5-pole 3.5mm captive screw, with output level control and configurable for balanced/unbalanced, analog stereo or dual mono
 - 2) One (1) HDMI, embedded and with output level control for two-channel PCM
 - 3) One RJ-45 for DTP2 twisted pair transmitting both:
 - (a) Embedded digital audio
 - (b) Pass-through stereo audio
 - c. Support embedding of the analog audio input signal on the HDMI and DTP2 outputs
 - d. Support extraction of two-channel PCM embedded audio signals to the analog stereo output, or pass bitstream audio to the HDMI and DTP2 outputs
 - e. Provide the capability of all four video inputs to share a common analog audio input
 - f. Provide a delay in the audio output to match the corresponding video processing delay

- (b) Two (2) RJ-45 for DTP2 twisted pair
 - 2) Provide automatic detection of input video parameters
 - (a) Determine total pixels, active pixels, active lines, H/V starting points, H/V image positions, H/V image sizes, and video clock phase
 - (b) The user may selectively enable to disable automatic detection for each input
 - 3) Provide image adjustments for brightness, contrast, color, tint, detail, H/V positioning, and sizing
 - 4) Provide storage and recall of video parameters and picture settings
 - (a) Automatic memories for each video input
 - (1) Save video settings and picture adjustments without user intervention
 - (2) Automatically recall settings when the same video rate is encountered
 - (3) The user may selectively enable or disable automatic memories
 - (b) Manual user presets
 - (1) Save picture adjustments
 - (2) User presets may be saved and recalled using front panel controls
 - (3) User presets may be saved and recalled electronically via Ethernet, RS-232 or USB connection
 - (c) Manual input presets
 - (1) Save video settings and picture adjustments
 - (2) Input presets may be saved and recalled electronically via Ethernet, RS-232 or USB connection
 - 5) Provide automatic 3:2 and 2:2 pulldown detection
- 2. Video Output Requirements
 - 1) Provide one (1) HDMI for loop-through without video scaling, selectable for any video input
 - 2) Provide video output connections
 - (a) One (1) HDMI unscaled output
 - (b) One (1) RJ-45 for DTP2 twisted pair scaled output
 - 3) Provide a range of selectable video output rates from 640x480 to 4096x2160 @ 60 Hz
 - 4) Support custom user-defined output resolutions via EDID management
 - 5) Provide image scaling and video format conversion with 30-bit precision and 4:4:4 chroma sampling
 - 6) Provide motion adaptive deinterlacing for signals up to 1080i
 - 7) Provide aspect ratio control
 - (a) When in FILL mode, the video image shall always fill the output screen without letterbox or pillarbox
 - (b) When in FOLLOW mode, the video image on the output screen shall always preserve the aspect ratio of the input signals without distortion
 - 8) Provide internal test patterns for calibration and setup
 - 9) Support image freeze via Ethernet, RS-232 or USB connection
- b. Support upload and placement of a custom logo graphic at any position on the video output
 - (a) Support logo placement as a foreground image
 - (b) Shall support uploading logo graphics in BMP, JPG, PNG, GIF, or TIFF format
 - (c) Shall support displaying full screen images up to 4096x2160 resolution
 - (d) Shall support up to 16 logo presets

- (e) Shall support keying with selectable effects including transparency, color key, level key, and alpha key
 - 2) Support automatic muting of video and sync output when no video input signal is present
 - (a) Provide a choice to generate a blue screen or a black screen before disabling sync
 - (b) Provide a configurable timeout period before disabling sync
 - (c) The user may selectively enable or disable automatic muting of sync output
 - 3) Provide a low power standby state selectable via Ethernet, RS-232 or USB
 - 4) Support the connection of DVI displays that do not recognize HDMI-specific formats
 - (a) Automatically enable or disable embedded TMDS audio and InfoFrames
 - (b) Automatically set the correct color space
 - 5) Support selection of output color space as RGB or component video
 - c. Switching Requirements
 - 1) Provide configurable automatic switching modes between input sources
 - (a) Last connected: always switch to the last active connected input
 - (b) Configurable priority: switching priority may be assigned arbitrarily for any combination of the inputs
 - 2) Provide selectable transition effects when switching inputs
 - (a) Seamless Cut: video output shall freeze, then cut to the newly selected input source
 - (b) Seamless Fade: video output shall freeze, then fade into the newly selected input source
 - (c) Cut through black: video output shall cut to black, then cut to the newly selected input source
 - (d) Fade through black: video output shall fade to black, then fade into the newly selected input source
 - (e) Accompanying audio shall ramp down, then ramp up to match the transition effect
 - d. EDID Requirements
 - 1) Provide automatic EDID management between connected devices
 - (a) Provide a set of pre-stored EDID files
 - (b) Support capture of EDID from any connected display
 - (c) Support user uploading of custom-generated EDID files
 - (d) Support assignment of any pre-stored, captured, or custom uploaded EDID file to any input connection
 - e. HDCP Requirements
 - 1) The unit shall be HDCP 2.3 compliant
 - 2) Provide authentication and maintain continuous verification of HDCP key exchange with connected sink devices
 - (a) Provide authentication and maintain continuous verification of HDCP key exchange with connected source devices
 - (b) Provide the option to disable HDCP processing at video inputs 2 through 8 when passing unencrypted content
 - (c) Provide selectable, human-readable visual confirmation of HDCP compliance when encrypted content is routed to a non-HDCP compliant display
 - (1) When enabled, the video output shall be a solid green color and an on-screen message stating “HDCP CONTENT” shall be displayed

- (2) When enabled, the option shall be provided to display a user-provided image in place of the green video output
 - (3) When disabled, the output shall be muted
 - 3) Provide real-time verification of HDCP status for each video input and output
 - (a) Directly readable on front panel LEDs
 - (b) Electronically accessible over Ethernet, RS-232 or USB connection
 - f. DTP2 Twisted pair requirements
 - 1) Provide signal transmission distance capability of 330 feet (100 meters) for all supported video resolutions using a shielded CATx cable
 - 2) Support video, audio, RS-232, IR, and power transmission over a single shielded CATx cable
 - 3) Shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - 4) Support computer and video resolutions up to 3840x2160/60 at 4:4:4 chroma sampling
 - 5) Support stereo audio pass-through signals
 - 6) Shall actively buffer DDC channels
 - 7) Shall be configurable for compatibility with
 - (a) Extron DTP inputs
 - (b) Extron DTP2 inputs
 - (c) Extron XTP matrix switcher inputs
 - (d) HDBaseT inputs
 - 8) Provide power to remote DTP or DTP2 endpoint connected over the shielded CATx cable
 - g. Audio Requirements
 - 1) Provide audio input connections
 - (a) One (1) DisplayPort, embedded
 - (b) Five (5) HDMI, embedded
 - (c) Two (2) 5-pole 3.5 mm captive screw, balanced/unbalanced line level analog stereo
 - (d) Two (2) 3-pole 3.5 mm captive screw, balanced/unbalanced mic/line level with +48 volt phantom power
 - 2) Provide audio output connections
 - (a) One (1) 2-pole, 5 mm captive screw, mono speaker level connector
 - (b) Two (2) 5-pole, 3.5 mm captive screw, with output level control and configurable for balanced/unbalanced, analog stereo or dual mono
 - (c) One (1) HDMI, embedded and with output level control for two-channel PCM
 - (d) One (1) RJ-45 for DTP2 twisted pair transmitting both:
 - (1) Embedded digital audio
 - (2) Pass-through stereo audio
 - (3) Provide mono amplification for high impedance speaker systems
 - (e) Support one mono speaker level signal on one 2-pole, 5 mm screw-lock captive screw connector
 - (f) Provide a total of 100 watts rms output power into a 70-volt load, measured at 1 kHz with 0.1% THD
 - (g) Provide a THD+N measurement of less than 0.1 % measured at 3 dB below clipping
 - (h) Provide a signal-to-noise ratio of greater than 90 dB measured from 20 Hz to 20 kHz, unweighted
 - (i) Utilize an efficient Class D amplifier design

- (j) Provide Class D Ripple Suppression technology
- (k) Provide an automatic clip limiter to detect onset of clipping by comparing input and output waveforms and automatically reduce gain with a slow attack and fast release to eliminate clipping distortion
- (l) Provide multiple protection circuits that activate during output shorts, thermal overload, or DC faults
- 3) Support embedding of the analog audio input signal on the HDMI and DTP2 outputs
- 4) Support extraction of two-channel PCM embedded audio signals to analog audio outputs, or pass bitstream audio to the HDMI and DTP2 outputs
- 5) Provide the capability for all video inputs to share a common analog audio input
- 6) Provide a delay in the audio output to match the corresponding video processing delay
- 7) Provide gain and attenuation adjustments for analog input audio
- 8) Support individual muting of the analog stereo or embedded digital audio outputs
- h. DSP Requirements
 - 1) Provide digital audio processing tools including gain, mixing, parametric EQ, filtering, dynamics, and ducking
 - 2) Provide adjustable, automatic ducking of program audio when a signal is detected on microphone inputs
 - 3) Provide DSP configuration and parameter adjustments through the product configuration software
 - 4) Provide real-time level meters for inputs and outputs in the product configuration software
 - 5) Provide live DSP parameter adjustments while they are heard or metered in real-time
 - 6) Provide user presets for saving and recalling DSP parameters
 - 7) Support storage and playback of up to 16 audio files at any audio output
- i. Integrated Control Processor Requirements
 - 1) Provide AV system control connections
 - (a) Three RJ-45: 10/100/1000Base-T Ethernet, half/full duplex with auto-detect for connection to a LAN and include link and activity LED indicators located on the left and right of each jack for troubleshooting network issues, these ports will be designated as AV LAN ports allowing for AV devices to be isolated from a corporate network.
 - (b) AV LAN ports shall support a DHCP server that can distribute 50 dynamic IP addresses with a 24-hour lease
 - (c) One RJ-45: 10/100/1000Base-T, half/full duplex with auto-detect for connection to a LAN or WAN and includes link and activity LED indicators located on the left and right of the jack for troubleshooting network issues.
 - (d) Two 3-pole 3.5 mm captive screw: RS-232, configurable for unidirectional or bidirectional control of AV system components
 - (e) One 5-pole 3.5 mm captive screw: RS-232/RS-422/RS-485, configurable for unidirectional or bidirectional control of AV system components
 - (f) Two IR/serial ports on one 5-pole 3.5 mm captive screw: IR (using an IR emitter) or unidirectional RS-232 for control of AV system components
 - (g) Four low voltage relays on one 6-pole 3.5 mm captive screw: configurable for controlling lighting, controlling screens, or other device functions

- (h) Four digital input/output ports on one 5-pole 3.5 mm captive screw: configurable for use as an interface with devices such as sensors, switches, LEDs, and relays
 - (i) One eBUS® port on a 4-pole 3.5 mm captive screw for connecting to eBUS devices
 - 2) Shall support the following protocols: ICMP (ping), IEEE 802.1X, IPv4, TCP, UDP, DHCP, DNS, HTTP, HTTPS, NTP, SFTP, SMTP, SNMP, SSH
 - 3) Shall support a Web-based AV resource management application that provides a means to manage, monitor, and control AV equipment
 - 4) Provide an internal real-time clock with a 30-year backup battery that is used to keep track of the date and time
 - 5) Shall support the addition of an Extron LinkLicense® for use of third party devices as primary control interfaces
 - 6) Provide front panel LED activity indicators for RS-232 status, RS-232/RS-422/RS-485 status, IR/serial status, digital I/O status, relay status, eBUS status, and network status
 - 7) Shall support control system synchronization to allow users to retain and recover configured endpoints in case of network or power failure
 - 8) Shall be configured using Extron Global Configurator® Plus or Extron Global Configurator Professional with support for the following:
 - (a) Provide support for up to eight configurable Extron TouchLink Pro touchpanels
 - (b) Provide support for up to eight configurable eBUS button panels
 - (c) Provide remote monitoring and control via Ethernet
 - (d) Provide the ability to create E-mail notifications
 - (e) Provide multiple levels of password protection
 - (f) Provide the ability to create schedules and monitors
 - (g) Support up to 32 Ethernet-controllable AV devices
 - (h) Support local variables and conditional logic
 - (i) Support grouping of multiple Extron IP Link® Pro control processors to function as one when configured with Global Configurator Professional
 - j. Security Requirements
 - 1) Support SFTP and SSH for secure communication between the control processor and a TouchLink Pro touchpanel or Network Button Panel
 - 2) Support HTTPS and SSH for secure communication between the control processor and Extron Control App
 - 3) Support HTTPS for secure communication between the control processor and Extron Control for Web
 - 4) Support SSH for secure communication between the control processor and controlled device for programmed systems
 - 5) Support SFTP and SSH for secure communication between the control processor and the configuration or programming software
 - 6) Provide the option to modify administrator and user credentials
 - 7) Support security updates to maintain network health
 - 8) Require that a Secure Socket Layer (SSL) Certificate is installed to maintain system confidentiality and data integrity
 - 9) Support the installation of an owner furnished certificate with the following properties:
 - (a) Certificates shall include x.509 support
 - (b) Certificates shall include public / private key exchange
 - (c) Certificates shall support PEM encoding

- 10) Extron shall furnish documentation that describes all supported network ports and services
- k. Control/remote - RS-232 and IR Pass-Through Over Shielded CATx Requirements
 - 1) Provide connections for AV device control
 - (a) One (1) 3-pole 3.5 mm captive screw: IR pass-through to a DTP twisted pair receiver
 - (b) Support Ethernet insertion of RS-232 signals for transmission to a DTP endpoint
 - 2) Support RS-232 and IR transmission over shielded CATx up to 330 feet (100 meters)
- l. Control/remote – Presentation Switcher Requirements
 - 1) Provide control connections
 - (a) One (1) RJ-45: 10/100/1000Base-T Ethernet
 - (b) One (1) 3-pole 3.5 mm captive screw: RS-232
 - (c) One (1) Mini USB-B: USB 2.0
 - 2) Provide alternatives for configuration and operation
 - (a) On-screen menus navigated using front panel controls
 - (b) Product configuration software connected via Ethernet, USB, or RS-232
 - (c) Serial commands sent over Ethernet, RS-232 or USB connection
 - 3) Support disabling of front panel controls to prevent inadvertent or unauthorized changes to configuration settings
 - 4) Support triggering of standard CEC commands at main HDMI and DTP2 outputs
- m. General Requirements
 - 1) Enclosure shall be rack-mountable, full rack width, and 2RU in height
 - 2) Shall be equipped with an internal 100-240 VAC, 50/60 Hz universal power supply
 - 3) Shall meet regulatory compliances
 - (a) Shall meet safety compliances under CE, c-UL, and UL
 - (b) Shall meet EMI/EMC compliances under CE, C-tick, FCC Class A, ICES, and VCCI
 - (c) Shall comply with appropriate requirements of RoHS and WEEE
 - 4) Shall provide three (3)-year parts and labor warranty
3. Approved device shall be the Extron DTP2 CrossPoint 82 IPCP MA 70 (part number 60-1812-03); no alternates or equals

2.13 SINGLE CHANNEL STREAMING MEDIA PROCESSOR - RACK MOUNTED:

- A. Provide an audio and video media processor that scales an HDMI signal with embedded audio, an additional analog audio signal, records, streams, and outputs an HDMI confidence signal with re-embedded audio. The processor shall allow simultaneous recording to an internal flash drive and customer-provided external USB drive. The product shall feature processing for the recording and the encoded stream. Each process shall have independent settings of resolution and bit-rate. The processor shall provide audio de-embedding, embedding, and audio mixing of both the HDMI input and an additional analog audio signal.
 1. Connection Requirements
 - a. Video Input Requirements
 - 1) Provide one rear accessible HDMI input
 - 2) One rear accessible captive screw connection for a single balanced or unbalanced line-level analog stereo audio signal
 - b. Video Outputs Requirements

- 1) Provide one rear accessible HDMI confidence output with re-embedded digital stereo audio
 - c. Support control connections to include:
 - 1) One front-accessible USB-mini connection
 - 2) One set of rear accessible RS-232 captive screw connections
 - d. One rear-accessible USB port for connection of an optional remote control panel, model RCP 101, or a keyboard and mouse
 - e. Support network and storage connections to include:
 - 1) One 10/100/1000 BASE-T female shielded RJ-45 network connection
 - 2) A front-accessible USB 1.1 / USB 2.0 port with support of high/full/low speeds for connecting removable storage devices
 - f. A rear-accessible USB 1.1 / USB 2.0 port with support of high/full/low speeds for connecting removable storage devices
 - g. Support 12V power connection
 - 1) Provide one rear captive screw connection for powering accessory devices including the optional remote control panel, model RCP 101
2. Video and Audio Processing Requirements
- a. Shall support the following input signal types:
 - 1) Video input resolutions from 640x480 to 1920x1200, including 480i, 480p, 576p, 720p, 1080i, 1080p
 - 2) Video input sampling up to 12bits per pixel, at resolutions up to 1080p pixel per pixel, and 1920x1200 with reduced blanking
 - 3) Analog video horizontal frequency from 15khz to 100khz, and vertical frequency from 24hz to 75hz
 - 4) Audio input levels from -18dB to +24dB with adjustable levels in 1dB increments
 - b. Incorporate an advanced video scaler capable of:
 - 1) Input scaling to include:
 - (a) Auto-image
 - (b) Auto-memory
 - (c) HDMI over scan from 0 -5%
 - c. Sixteen selectable input presets
 - d. Provide picture controls to maximize source image quality, including:
 - 1) Brightness
 - 2) Contrast
 - 3) Position
 - 4) Size
 - 5) Zoom
 - e. Provide a clean image when connecting or disconnecting sources
 - f. Allow position and sizing of HDMI source content
 - g. Include the following aspect ratio options when scaling video sources:
 - 1) Video output fills display
 - 2) Video output maintains source's original aspect ratio with no image cropping
 - 3) Video output maintains source's original aspect ratio and is cropped to fill display
 - h. Provide HDCP signal notification of an encrypted source on the HDMI input, with selectable authorization for unencrypted content
 - i. Identify HDCP encrypted content on non-compatible output, media and stream with a green screen wash and HDCP message
 - j. Automatically manage EDID communications to the connected HDMI source

- k. Support for overlaying metadata on video recordings and streams
 - l. Include audio mixing and DSP processing for clean audio blending of embedded and analog source inputs
 - m. Include overlay of time reference using HH:MM:SS format on the video output
 - n. Support of multiple internal test patterns for setup and configuration
 - o. Support time delay synchronization of audio to video through the encoder preventing lip sync errors
3. Network Requirements
- a. Include one 10/100/1000 BASE-T RJ-45 female shielded network connection with support for:
 - 1) Live streaming
 - 2) Transport of recording packages to network locations
 - 3) Access to embedded web interface
 - 4) Interfacing with AV control systems
 - b. Include networking configurations for the following:
 - 1) Configurable MTU from 68 to 1500
 - 2) DHCP or Static IP addressing
 - c. Configurable ports numbers including ability to disable ports for:
 - 1) HTTP
 - 2) HTTPS
 - 3) Telnet
 - 4) SSH
 - 5) SFTP
 - 6) SNMP
 - d. Support for NTP time synchronization with time zone offset
 - e. Support for Network configuration backup and restore via downloadable configuration file
 - f. Include ability to view and set basic network configuration parameters via the internal web pages.
 - g. Support network protocols including:
 - 1) IGMPv3 (RFC 3376)
 - 2) TCP/IP
 - 3) UDP
 - 4) SSL
 - 5) DHCP
 - 6) HTTP
 - 7) HTTPS
 - 8) RTP
 - 9) RTSP
 - 10) RTMP
 - 11) SNMP V2 (RFC 1213)
 - 12) SAP (RFC2974)
 - 13) SDP (RFC4566)
 - 14) QoS (RFC 2474)
 - 15) NTPv4 (RFC 4330)
 - h. Support file transfer protocols including:
 - 1) FTP
 - 2) SFTP
 - 3) CIFS
 - i. Support network file share protocols including:

- 1) CIFS/SMB
- 2) NFS
- j. Support Email notifications over SMTP Messaging
4. Streaming Requirements
 - a. Include an encoder using H.264 video compression and AAC Audio Compression
 - b. Support streaming of the combined elements from an HDMI input and an analog audio input.
 - c. Independent settings from the recorder for stream parameters to include:
 - 1) Support for push or pull streaming session management
 - 2) Support for either multicast or unicast streaming
 - 3) Support for frame rate from 5fps to 30fps
 - d. Include streaming resolutions of 512x288 to 1080p
 - e. Include Streaming Profiles to include Base, Main, and High, and Levels including 3.0 – 4.1.
 - f. Support video streaming bit rates from 200 kbps to 10 Mbps
 - g. Support rate controls including VBR, CBR, and CVBR
 - h. Support adjustable audio streaming bit rates from 80 kbps to 320 Kbps
 - i. Support RTSP session management
 - j. Support RTMP push streaming with authentication to hosting services
 - k. Support use of RTP/RTCP streaming transport protocols
 - l. Support use of native RTP and MPEG-2 Transport Streams (TS) in unicast or multicast
 - m. Support of Transport Streams (TS) on UDP or RTP/UDP
 - n. Support use of SAP and SDP protocols
 - o. Support RTP/RTSP, interleaved RTSP and HTTP tunneled pull streaming transport protocols
 - p. Include Audio Delay to match video delay caused by external devices (Lip Sync)
 - q. Support saving and recall of 16 Streaming profile presets
5. Recording Requirements
 - a. Shall record and stream simultaneously at resolutions from 512x288 up to 1920x1080 (1080p)
 - b. Shall record and stream simultaneously at refresh frequencies of 5 – 30 Hz
 - c. May record to both internal flash drive and external USB drive simultaneously
 - d. Shall support USB Storage with the following file formats:
 - 1) Fat32
 - 2) NTFS
 - 3) VFAT (long file name ext)
 - 4) EXT2
 - 5) EXT3
 - 6) EXT4
 - e. Shall provide a 32 Gigabyte internal flash drive for recording storage
 - f. Shall provide a front panel and rear panel indicator light for connected USB activity
 - g. Shall provide recording of content for the following:
 - 1) Store recorded audio visual files in a M4V or MP4 format
 - 2) Store recorded audio only files in M4A format
 - 3) Store JPEG thumbnail files in either reduced resolution of 848x480, or at the specified recorder resolution
 - 4) Metadata information contained within a JSON file shall including the following fields:
 - (a) Title

- (b) Language
 - (c) Contributor
 - (d) Publisher
 - (e) Coverage
 - (f) Course Name
 - (g) Presenter
 - (h) Copyright
 - (i) Date Time
 - (j) Source
 - (k) Description
- h. Subject
 - i. Format
 - 1) Chapter markers shall index time stamp information
 - j. Shall provide recording status, available space, and recording time available based upon current settings
 - k. Shall provide independent information for each storage device connected
 - l. Shall provide file naming options including the use of metadata, and either UTC or local time
 - m. Shall create JPEG thumbnail images at scheduled intervals and at index marks while recording
 - n. Shall create a daily recording report detailing usage and operating data
6. Controls and Automation Requirements
- a. Allow direct system operation from illuminated front panel controls of the following functions:
 - 1) Record
 - 2) Pause
 - 3) Stop
 - 4) Mark
 - b. Include LED indicators for the following:
 - 1) One green LED for HDMI source detection
 - 2) One green LED for HDCP encrypted source detection
 - 3) Two green and two red LED's for relative audio level and clipping from HDMI and analog inputs
 - 4) One green and one red LED for relative audio level and clipping of the output level
 - 5) One red LED for Alarm notification
 - 6) One green LED for power indication
 - c. Include a reset button and associated LED to restore the unit to one of four pre-defined, programmed operational configurations.
 - d. Include an embedded web page for configuration, monitoring, and control that includes a confidence view of the video output
 - e. Include a means to lock out all of the front panel controls
 - 1) All serial, USB and network controls remain active
 - f. Support the automatic transfer of content after a recording, without interrupting any other functions
 - g. Include automated disk management to facilitate the deletion of old files to make room for new recordings
 - h. Support for alarm notification of events by logging, front panel notification, and email notification
 - i. Support for event logging, and diagnostics

- j. Support remote control functions over RS-232, Telnet, SSH, in addition to the web browser interface
- 7. Enterprise Integration Requirements
 - a. Integrate directly with the following content management systems:
 - 1) Entwine Enterprise Media Platform
 - 2) Opencast content management systems
 - 3) Kaltura content management systems
 - b. Include automated transfer of recorded packages to:
 - 1) FTP Site
 - 2) SFTP Site
 - 3) CIFS server network file share
 - c. Support recordings that are compatible with Learning Managements Systems such as:
 - 1) iTunes U
 - 2) Blackboard LMS
 - 3) SharePoint
 - 4) Captionsync
 - 5) YouTube
 - 6) Moodle
 - 7) RSS Feed
 - d. Include transfer of content to an LTI connected content management system
 - e. Support system workflow alarms for events including:
 - 1) Loss of video or audio
 - 2) HDCP encryption
 - 3) Disk space or disk errors
 - 4) Recording suspended
 - 5) CPU usage
 - f. Support automated email of error conditions and log information to defined support staff
 - g. Support for SNMP v2 and SNMP v3 monitoring
- 8. General Requirements
 - a. Device shall be housed in a 1RU, half EIA rack width metal enclosure
 - b. Device shall be rack mountable using an optional rack shelf, not included
 - c. Shall be equipped with an internal 100 – 240VAC, 50-60Hz universal power supply
 - d. Shall meet regulatory compliances
 - 1) Shall be certified to meet safety compliances under CE, c-UL, and UL
 - 2) Shall meet EMI/EMC compliances under CE, C-tick, FCC Class A, ICES, and VCCI
 - 3) Shall comply with requirements of RoHS and WEEE
 - e. Shall provide three year parts and labor warranty

B. The approved device shall be the Extron SMP 111 (60-1594-01); no alternates or equals.

2.14 SUBWOOFER AMPLIFIER:

A. Approved device shall be the Extron NetPA U 8001 SUB, part number 60-1866-01; no alternates or equals

2.15 AUDIO AMPLIFIER:

A. Provide a compact, energy efficient audio amplifier that shall support two analog inputs and two amplified outputs with 200 watts rms per channel into a 70 volt line.

- 1. Compact stereo amplifier with 200 watts rms power output per channel into a 70 volt line and ENERGY STAR® qualification
- 2. Input Requirements

- a. Shall support two, balanced or unbalanced line level signals on two 3-pole, 3.5 mm captive screw connectors
3. Output Requirements
 - a. Shall support two high impedance speaker level signals on two 2-pole, 5 mm screw-lock captive screw connectors
 - b. Shall provide a total of 400 watts rms output power with 200 watts rms per channel into a 70 volt line measured at 1 kHz with 0.1% THD
 - c. Shall provide a signal-to-noise ratio of 100 dB measured from 20 Hz to 20 kHz, unweighted
 - d. Shall provide a minimum load impedance of 25 ohms
 - e. Shall provide a THD+N measurement of 0.1% measured at 3 dB below clipping
 - f. Shall provide a damping factor of greater than 100 at 25 ohms
 - g. Shall provide a switch-selectable high pass filter for frequencies below 80 Hz with a 12 dB per octave rolloff
4. Amplifier Requirements
 - a. Shall utilize an efficient Class D amplifier design
 - b. Shall provide Class D Ripple Suppression technology
 - c. Shall be convection cooled and operate without fans or vents
 - d. Shall provide an automatic clip limiter to detect onset of clipping by comparing input and output waveforms and automatically reduce gain without audible artifacts to eliminate clipping distortion
 - e. Shall provide multiple protection circuits that activate during output shorts, thermal overload, or DC faults
 - f. Shall provide power factor correction technology to remove harmonic content on the AC power line
5. Power Requirements
 - a. Shall draw 84.5 watts during typical (1/8 power) operation
 - b. Shall draw 20.8 watts during quiescent operation
 - c. Shall provide a low power standby mode
 - 1) Shall enter standby mode after 25 minutes (+/- 5 minutes) of inactivity
 - 2) Shall draw less than 1 watt while in standby mode
 - 3) Shall return to full power status in less than one second upon signal detection while in standby mode
 - 4) Shall feature an input signal detection threshold of -40 dBu, +/- 3 dB on a balanced input to deactivate standby mode
 - d. Shall be ENERGY STAR qualified
 - e. Shall provide an internal universal power supply with IEC power socket and support for international 100-240 VAC, 50/60 Hz standards
6. Control Requirements
 - a. Shall support remote standby control on one 2-pole, 3.5 mm captive screw connector
7. Front Panel Requirements
 - a. Shall provide an LED for power indication that lights green when the unit is receiving power and active, and lights amber when the unit is in standby mode
 - b. Shall provide an LED for indication of the enclosure temperature exceeding the optimal value
 - c. Shall provide green LEDs for input signal presence indication
 - d. Shall provide red LEDs for indication of clip warning and protection circuit activation
8. Rear Panel Requirements
 - a. Shall provide two inputs on two 3-pole, 3.5 mm captive screw connectors
 - b. Shall provide two outputs on two 2-pole, 5 mm screw-lock captive screw connectors
 - 1) Shall support 22 AWG to 12 AWG speaker cables

- c. Shall provide standby control port on one 2-pole, 3.5 mm captive screw connector
 - d. Shall provide recessed, detented potentiometers for attenuation adjustment
 - e. Shall provide a switch for selecting a high pass filter to roll off frequencies below 80 Hz with a 12 dB per octave rolloff
 - f. Shall provide an LED for power indication that lights green when the unit is receiving power and active, and lights amber when the unit is in standby mode
 - g. Shall provide green LEDs for input signal presence indication
 - h. Shall provide red LEDs for indication of clip warning and protection circuit activation
9. General Requirements
- a. Shall be enclosed in a rack-mountable 1U, full rack width metal enclosure
 - b. Shall meet regulatory compliances
 - 1) Shall meet safety compliances under BSMI, CCC, CE, c-UL, GS, KC Mark, PSE, S-Mark, and UL
 - 2) Shall meet UL 60065, IEC 60065, and BSEN 60065 for safety
 - 3) Shall meet EMI/EMC compliances under CE, CISPR 22 Class B, CISPR 24, C-tick, EN55103-1, EN55103-2, FCC Class B, ICES, KCC, and VCCI Class B
 - 4) Shall comply under the appropriate requirements of ENERGY STAR, EU code of conduct, RoHS, and WEEE
 - c. Shall provide three years parts and labor warranty
- B. Approved device shall be the Extron XPA 2002-70V, part number 60-883-02; no alternates or equals.

2.16 TOUCH PANEL – 7" WALL MOUNT:

- A. Provide a 7" capacitive touchscreen interface for switching and control of AV equipment
- 1. Wall mountable 7" touchscreen user interface for AV and control systems
 - a. Provide a 7" LCD touchscreen that supports up to 16.7M colors and 1024x600 resolution
 - b. Device shall feature scratch and smudge-resistant Corning® Gorilla Glass®
 - c. Device shall support Extron IP Link Pro control processors
 - d. Device shall include a built-in down firing speaker which can be configured to provide audio and button feedback
 - e. Device shall have a female RJ-45 jack located on the back of the enclosure that supports 10/100/1000Base-T, half/full duplex with auto-detect for connection to a LAN or WAN and includes link and activity LED indicators located on the left and right of the jack for troubleshooting network issues as well as supports PoE- Power over Ethernet, 802.3af
 - f. Device shall include a single high-speed micro USB 2.0 type B receptacle located on the back of the enclosure
 - g. Provide two red/green LEDs along the left and right sides of the display to indicate room status, six rear-facing, red/green LEDs located on the back of the enclosure to provide ambient light to the mounted area and radiates a soft glow behind the panel to enhance visibility from distant locations, all of which can be configured or programmed as a group.
 - h. Device shall feature a digital input on the back of the panel
 - i. Provide a built-in motion sensor located on the top bezel of the touch surface allowing the panel to be woken from a sleep state or set up via software to trigger any number of actions
 - j. Provide a light sensor located on the top bezel of the touch surface that automatically adjusts the LCD screen's backlight based on available ambient light
 - k. Provide a front panel status LED that blinks red if the touchpanel loses network connectivity with the control processor

- l. Device shall have a menu button located on the back setup of items such as IP address and sound volume at minimum
 - m. Device shall include a multi-function button located on the back of the enclosure that allows for the reset of the device or its communication properties at minimum
 - n. Device shall support the following protocols: DHCP, DNS, HTTP, HTTPS, ICMP, SFTP, SSH, TCP/IP, UDP/IP
 - o. Device shall have the following memory available, at minimum:
 - 1) SDRAM
 - (a) 2 GB
 - 2) Flash
 - (a) 4 GB
 - p. Device shall have the ability to be controlled by an HTML5 and JavaScript or Silverlight enabled web browser, or an iOS or Android based device as a secondary point of control
 - q. Device shall be black in color
2. Mounting requirements
 - a. Device shall have the ability to be mounted directly in a wall, lectern, or other flat surface and shall be able to be secured using the included mounting plate
 - b. Device shall have the ability to be recessed in the wall using an optional recessed wall mount kit
 - c. Device shall have the ability to be mounted to a glass surface using an optional glass mounting kit
 - d. Device shall have the ability to be mounted into a rack using an optional rack mount kit
 3. Software requirements
 - a. User interface shall be created using Extron's GUI Designer software
 - b. The device may only be configured or programmed using Extron's Global Configurator Plus or Professional, or Global Scripser respectively.
 - c. Shall be configured or programmed by an Extron authorized user.
 - d. The device's configuration and settings shall be managed using Extron's Toolbelt software
 4. Security requirements
 - a. Device shall support SFTP and SSH for secure communication between the control processor and TouchLink Pro touchpanel.
 - b. Device shall support SFTP and SSH for secure communication between the control processor and the configuration or programming software
 - c. Device shall provide the option to modify administrator and user credentials
 - d. Device shall support security updates to maintain network health
 - e. Device shall require that a Secure Socket Layer (SSL) Certificate is installed to maintain system confidentiality and data integrity
 - f. Device shall support the installation of an owner furnished certificate with the following properties:
 - 1) Certificates shall include x.509 support
 - 2) Certificates shall include public / private key exchange
 - 3) Certificates shall support PEM encoding
 - g. Extron shall furnish documentation that describes all supported network ports and services
 5. Shall meet regulatory compliances
 - a. CE
 - b. c-UL
 - c. UL

- d. C-Tick
 - e. FCC Class B
 - f. ICES
 - g. VCCI
 - h. RoHS
 - i. WEEE
6. Product Warranty
- a. Shall provide at least 3 years parts and labor
 - b. Shall provide 1-year touchscreen and overlay components
- B. Approved device shall be the Extron TLP Pro 725M, part number 60-1563-02; no alternates or equals

2.17 AUDIO SIGNAL PROCESSOR:

- A. Provide an audio digital signal processor that shall support six mono analog inputs capable of microphone or line level signals and four mono analog line level outputs for signal routing and management.
1. Six input, four output audio digital signal processor with 64-bit floating point DSP engine and 24-bit/48 kHz audio converters
- a. Input Requirements
 - 1) Shall support six mono, microphone or line level, balanced or unbalanced signals on six 3-pole, 3.5 mm captive screw connectors
 - 2) Shall provide input gain adjustment from -18 dB to +80 dB in 0.1 dB steps, adjustable per input
 - 3) Shall provide selectable +48 volt phantom power for condenser microphone on each input
 - 4) Shall provide analog to digital conversion at 48 kHz sampling rate with 24-bit resolution
 - b. Output Requirements
 - 1) Shall support four mono line level, balanced or unbalanced signals on four, 3-pole, 3.5 mm captive screw connectors
 - 2) Shall provide output attenuation adjustment from 0 dB to -100 dB in 0.1 dB steps, adjustable per output
 - 3) Shall provide digital to analog conversion at 48 kHz sampling rate with 24-bit resolution
 - c. DSP Engine Requirements
 - 1) Shall provide 64-bit floating point DSP engine
 - 2) Shall support 32-bit and 64-bit processing algorithms depending on process
 - 3) Shall provide a maximum, deterministic latency of 4.5 ms from input to output
 - d. Audio Device Requirements — Input to Output
 - 1) Shall provide a signal-to-noise ratio of greater than 105 dB measured from 20 HZ to 20 kHz, at maximum output, unweighted
 - 2) Shall provide a THD+N measurement of less than 0.01%, measured at 1 kHz, at maximum output level
 - e. Configuration Software Requirements
 - 1) Shall provide PC-based DSP Configurator software allowing flexible control of the digital signal processor's fixed architecture
 - 2) Shall provide a Live mode for real-time control of parameters without compiling and file uploading to processor
 - 3) Shall provide an Emulate mode for offline configuration
 - 4) Shall provide single window view of all inputs and outputs, audio processing blocks, routing, mix points, and virtual routing

- 5) Shall provide setup and configuration of digital audio processing tools including, but not limited to: Filters (high pass, low pass, bass, treble and parametric EQ); Dynamics processing (AGC, compressor, limiter, noise gate); Delay processing; Ducking processing; Loudness processor; Feedback Suppressor; and multiple gain stages
 - 6) Shall provide cut and paste editing between processing blocks
 - 7) Shall provide matrix routing with integrated mix point gain adjustment between inputs, outputs, virtual sends, and virtual returns
 - 8) Shall provide a library of pre-designed processor settings for inputs and outputs with user-customizable parameters
 - 9) Shall provide 32 Group Master controls for consolidation of up to 16 individual gain or mute control members of the same type into one point of control
 - 10) Shall provide Soft Limits settings to define upper and lower control limits on Group Masters for use with external controls
 - 11) Shall provide 32 Presets for recall of any processing block setting, level setting or audio routing; presets shall be saved for the entire system, or any selected partial group of inputs, outputs mix points, and DSP blocks
 - 12) Shall provide real-time meters of levels within each Input Gain, AGC, Compressor, Limiter, Noise Gate, and Output Volume processing block in Live mode
 - 13) Shall provide a Meter Bridge window for real-time metering of all input and output channels with clipping indication in Live mode
 - 14) Shall provide keyboard-based navigation software utilizing directional controls, keyboard shortcuts, and spreadsheet software-style commands
 - 15) Shall provide file saving in both Live and Emulate mode
 - 16) Shall provide file upload in both Live and Emulate mode
- f. Control Requirements
- 1) Shall provide Ethernet monitoring and control using standard TCP/IP protocols to support real-time monitoring and system management over a LAN or WAN on RJ-45 connector
 - 2) Shall support two bidirectional RS-232 ports on two 3-pole, 3.5 mm captive screw connectors
 - 3) Shall support USB 2.0 control on female mini USB B connector
 - 4) Shall support remote control operation via external control system using Simple Instruction Set commands sent over RS-232 on 3-pole, 3.5 mm captive screw connectors or Ethernet on RJ-45 connector
 - 5) Shall provide six digital I/O ports on 3-pole, 3.5 mm captive screw connectors for processor remote control and/or feedback to external control system or physical devices
- g. Front Panel Requirements
- 1) Shall provide a green LED for power indication
 - 2) Shall provide Configuration port on mini USB B connector
 - 3) Shall provide green LEDs for input and output signal presence indication
 - 4) Shall provide red LEDs for clip warning indication
- h. Rear Panel Requirements
- 1) Shall provide LEDs for phantom power indication
 - 2) Shall provide six inputs on 3.5 mm captive screw connectors
 - 3) Shall provide four outputs on 3.5 mm captive screw connectors
 - 4) Shall provide six digital input/output ports on 3.5 mm captive screw connectors
 - 5) Shall provide two bidirectional RS-232 ports on 3.5 mm captive screw connectors

- 6) Shall provide Ethernet host port on RJ-45 connector
- i. General Requirements
 - 1) Shall provide energy-efficient external universal power supply with 2-pole captive screw connector
 - (a) Shall be universal in-line power supply with IEC power socket and support for international 100-240 VAC, 50/60 Hz standards
 - (b) Shall provide output of 12 VDC, 1 A, 12 watts
 - (c) Shall support use of optional Extron ZipClip™ 200 mounting bracket
 - (d) Shall meet energy efficiency level V and bear the UL Environment Energy Efficiency Certification (EEC) Mark
 - 2) Shall be enclosed in a rack-mountable 1U, half rack width metal enclosure
 - 3) Shall meet regulatory compliances
 - (a) Shall meet safety compliances under CE, c-UL, and UL
 - (b) Shall meet EMI/EMC compliances under CE, C-tick, FCC Class A, ICES, and VCCI
 - (c) Shall comply with appropriate requirements of RoHS and WEEE
 - 4) Shall provide three year parts and labor warranty

B. Approved device shall be the Extron DMP 64, part number 60-1054-01; no alternates or equals.

2.18 CONTROL PROCESSOR:

- A. Provide an Ethernet-enabled control processor for the purpose of remotely controlling, monitoring and troubleshooting connected AV equipment and AV systems.
 1. Ethernet-enabled control processor
 - a. Provide one RS-232 port on a captive screw connector located on the back of the processor that can be configured for unidirectional or bidirectional control of AV system components
 - b. Provide one RS-232/RS-422/RS-485 port on a captive screw connector located on the back of the processor that can be used for unidirectional or bidirectional control of AV system components
 - c. Provide one IR/Serial port on a captive screw connector located on the back of the processor. This port shall allow the transmission of IR signals (using an IR emitter) or unidirectional RS-232 communications for control of AV system components
 - d. Provide two low voltage relays on captive screw connectors located on the back of the processor that can be used to control lighting, screens, or other device functions.
 - e. Provide four digital I/O's on captive screw connectors that can be used to interface with devices such as sensors, switches, LEDs and relays
 - f. Provide one eBUS® port on a 4-pole captive screw connector located on the back of the control processor for connecting to eBUS devices
 - g. Provide a remote volume control port for the Extron MPA Series and select XTRA™ Series amplifiers
 - h. Supports the creation of IR drivers by capturing IR commands from handheld remotes. IR receiver shall be located on the bottom right front of the processor and integrated into the control processor enclosure
 - i. Device shall have a female RJ-45 jack located on the back of the enclosure that supports 10/100/1000Base-T, half/full duplex with auto-detect for connection to a LAN or WAN and includes link and activity LED indicators located on the left and right of the jack for troubleshooting network issues
 - j. Device shall support the following protocols: ICMP (ping), IEEE 802.1X, IPv4, TCP, UDP, DHCP, DNS, HTTP, HTTPS, NTP, SFTP, SMTP, SNMP, SSH
 - k. Device shall have a 12-volt captive screw connection located on the back of the panel

- l. Device shall include a multi-function button that allows for the reset of the device or its communication properties at minimum
 - m. Supports a web-based AV resource management application that provides a means to manage, monitor, and control AV equipment
 - n. Provide an internal real-time clock with backup battery that is used to keep track of the date and time
 - o. Device shall have at least 4.5 GB of nonvolatile memory with at least 4.2 GB available to the user
 - p. Provide front panel LED activity indicators for power status, eBUS status, RS-232/RS-422/RS-485 status, RS-232 status, IR/S status, digital I/O status, relay status, and network status
 - q. Device shall include an energy-efficient external 12 VDC, 1 A power supply
 - r. Device shall support the addition of an Extron LinkLicense®
2. Mounting requirements
 - a. Device shall be housed in a 1 RU, quarter rack width metal enclosure
 - b. Device shall be rack mountable using an optional rack shelf
 - c. Device shall be able to be installed under a table, desk, or other flat surface using an optional mounting kit
 - d. Device shall be mountable on a projector mounting pole using an optional mounting kit
3. Software requirements
 - a. The device may only be configured or programmed using Extron's Global Configurator Plus or Professional, or Global Scripiter respectively.
 - b. Device drivers and modules can be obtained through Extron support resources and database.
 - c. Shall be configured or programmed by an Extron authorized user.
 - d. The device's configuration and settings shall be managed using Extron's Toolbelt software
4. Security Requirements
 - a. Device shall support SFTP and SSH for secure communication between the control processor and a TouchLink Pro touchpanel or Network Button Panel
 - b. Device shall support HTTPS and SSH for secure communication between the control processor and Extron Control App
 - c. Device shall support HTTPS for secure communication between the control processor and Extron Control for Web
 - d. Device shall support SSH for secure communication between the control processor and controlled device for programmed systems
 - e. Device shall support SFTP and SSH for secure communication between the control processor and the configuration or programming software
 - f. Device shall provide the option to modify administrator and user credentials
 - g. Device shall support security updates to maintain network health
 - h. Device shall require that a Secure Socket Layer (SSL) Certificate is installed to maintain system confidentiality and data integrity
 - i. Device shall support the installation of an owner furnished certificate with the following properties:
 - 1) Certificates shall include x.509 support
 - 2) Certificates shall include public / private key exchange
 - 3) Certificates shall support PEM encoding
 - j. Extron shall furnish documentation that describes all supported network ports and services
5. Shall meet regulatory compliances

- a. CE
 - b. c-UL
 - c. UL
 - d. C-Tick
 - e. FCC Class A
 - f. ICES
 - g. VCCI
 - h. RoHs
 - i. WEEE
6. Product Warranty
- a. Shall provide at least 3 years parts and labor
- B. Approved device shall be the Extron IPCP Pro 250, part number 60-1429-01; no alternates or equals

2.19 CEILING SPEAKERS - PENDANT MOUNT

- A. Provide a two-way, plastic enclosure, pendant speaker that shall provide an internal transformer.
- 1. Two-way, plastic enclosure, pendant speaker with internal transformer for 8 ohm direct and 70/100 volt operation
 - a. Driver Requirements
 - 1) Shall consist of a 6.5" (165 mm) polypropylene woofer with moisture resistant coating and a 3/4" (19 mm) PEI dome tweeter
 - b. Performance Requirements
 - 1) Shall provide a frequency range of 70 Hz to 20 kHz, -10 dB below average SPL, measured on-axis in full space (per IEC 60268-5)
 - 2) Shall provide a power handling capacity of 65 watts (rms) continuous pink noise (per IEC 60268-5) and 130 watts (rms) continuous program
 - 3) Shall provide a nominal sensitivity of 86 dB SPL (1 W, 1 m) measured in full space (per IEC 60268-5)
 - 4) Shall provide a nominal impedance of 8 ohms per speaker
 - 5) Shall provide a nominal conical coverage angle of 95° (1 kHz to 4 kHz)
 - c. Electrical Requirements
 - 1) Shall support 8 ohm direct or 70/100 volt connection from power amplifiers
 - 2) Shall provide a six-position power tap selector, located at the bottom of the enclosure under a removable speaker grille
 - (a) Shall provide selectable rotary switch taps for 70 volt operation, including 64 watts, 32 watts, 16 watts, 8 watts, and 8 ohms direct
 - (b) Shall provide selectable rotary switch taps for 100 volt operation, including null, 64 watts, 32 watts, 16 watts, and 8 ohms direct
 - 3) Shall support one incoming and one outgoing speaker level signal on two splicing connectors
 - (a) Shall support wiring multiple speakers using parallel or loop-through wiring
 - (b) Shall support Extron PendantConnect speaker cable, model PCC-2 18
 - d. Speaker Enclosure Requirements
 - 1) Shall provide a fire-resistant (UL94V-0) plastic, tapered cylindrical enclosure
 - (a) Shall measure 9.0 inches (229 mm) in diameter at its widest point
 - (b) Shall be available with a white or black, paintable finish
 - (c) Shall include removable cap for the top of the enclosure such that the connection points are not visible when the cap is in place
 - e. General Requirements

- 1) Shall be sold in pairs
 - 2) Shall include 30 feet (9.1 m) of Extron PendantConnect PCC-2 18 speaker cable that incorporates the speaker wires, a steel support cable, and a steel safety cable into a single outer jacket
 - 3) Shall meet regulatory compliances
 - (a) Shall meet safety compliances under CE, UL1480
 - (b) Shall meet UL 1480 for commercial and professional audio systems
 - (c) Shall comply with appropriate requirements for RoHS and WEEE
 - 4) Shall provide five year parts and labor warranty
- B. Approved device shall be the Extron SF 26PT, part numbers 60-1752-02 for black or 60-1752-03 for white; no alternates or equals.

2.20 CEILING SUBWOOFERS

- A. Provide a suspension mounted subwoofer that can be installed in physical isolation from a ceiling structure.
1. Fourth order bandpass, ported subwoofer, with 8 ohm direct connection to a power amplifier
 - a. Driver Requirements
 - 1) Shall consist of a 10" (254 mm) polypropylene cone woofer
 - b. Performance Requirements
 - 1) Shall provide a frequency range of 25 Hz to 160 Hz, -10 dB, half space per IEC 60268-5
 - 2) Shall provide a power handling capacity of 400 watts (rms) continuous pink noise per IEC 60268-5 and 800 watts (rms) continuous program
 - 3) Shall provide a nominal sensitivity of 93 dB SPL (1 W, 1 m), corner loaded
 - 4) Shall provide a nominal impedance of 8 ohms per speaker
 - 5) Shall provide a maximum SPL of 116 dB, 1 m, based on maximum input voltage, full space
 - c. Electrical Requirements
 - 1) Shall support 8 ohm direct connection from a power amplifier
 - 2) Shall include one 4-pole, 5 mm captive screw connector for double wiring
 - (a) Shall support a maximum wire gauge of 12 AWG per connection point
 - 3) Shall support a maximum input voltage of 35.7 V, 160 watts at 8 ohms, per AES2-2012
 - d. Speaker Enclosure Requirements
 - 1) Shall be a ported, fourth order bandpass enclosure
 - 2) Shall measure 39.36" (100 cm) in total length from port to rear
 - 3) Shall measure 15.83" (40.2 cm) in total height from bottom of port to top of mounting bracket
 - 4) Shall weigh 38 lbs (17.2 kg)
 - 5) Shall require 7.6" (193 mm) diameter opening in mounting surface for speaker cutout
 - e. General Requirements
 - 1) Shall include a grille assembly kit, cutout template, cable locks, cable clamps, mounting cables, isolation grommets, and eye bolts
 - 2) Shall mount horizontally in the ceiling with included parts or vertically on the floor with the optional SMK F SF 10C kit, part number 70-1247-01, no alternates or equals
 - 3) Shall be UL 2043 plenum rated
 - 4) Shall have a cable/conduit access plate
 - 5) Shall be compatible with Extron SGK SF3C Square Grille Kit

- 6) Shall meet regulatory compliances
 - (a) CE, RoHS, UL 1480A, UL 2043, WEEE
 - 7) Shall provide five year parts and labor warranty
- B. Approved device shall be the Extron SF 10C SUB, part number 60-1610-01; no alternates or equals.

2.21 CABLING AND CONNECTORS

A. HDBaseT Cables

1. Cabling channels supporting HDBaseT signals shall be TIA/ISO Category 6A/Class EA compliant, utilizing Shielded or Noise Cancelling Isolation Wrap (segmented shield) cable and appropriate termination components.
2. The cabling channel shall comply with Power over HDBaseTTM (POH) applications up to 100 watts
3. Utilize Cat6A UTP cable as described in Horizontal Cabling section 27 15 00 for HDBaseT and other AV connections in this Section.

B. HDBaseT Connectors

1. Modular Connectors shall be 8P8C (RJ45) CAT6A UTP Plenum-Rated jacks as described in Horizontal Cabling section 27 15 00.
2. Connectors shall be die cast, QuickPort (Keystone) footprint, rear gate latching, and fit in any faceplate, biscuit block or ceiling/box mount provided for in this Specification.
3. Connector module shall be UL 2043 Plenum Certified. Wiring shall be universal and will accommodate both T568A and T568B pair/pin assignments. T568B shall be used.
4. Connector Module shall be supplied with interchangeable icons (voice, data, A/V, and blank, color coded to match the connector face) for easy identification and tracking of data, voice, or other functions and shall be available in 13 different colors.

C. HDMI and USB Connectors

1. HDMI and USB pass-through connectors landing in faceplates shall fit surrounding connectors in the same Quickport keystone-style device plate.

D. HDBaseT Patch Cords

1. Category 6A Component rated Slimline Patch Cords as described Connecting Cords section 27 16 00 shall be used for HDBaseT interconnections in the transition from HDMI or VGA into UTP cabling.

E. HDMI Cable Assemblies

1. Cable shall be High-Speed HDMI with Ethernet and shall be HDMI certified.
2. The cable shall be rated CL2 for in-wall installations, be cULus Listed to UL 1863 and CAN/CSA C22.2 No. 233-09.
3. HDMI cables shall be manufactured with gold plated Type A male HDMI connectors with molded TPE connector outer body.
4. HDMI cables shall be manufactured with 28ga conductors and have an outside diameter of no greater than 0.27”
5. HDMI cables shall support Audio Return Channel.
6. HDMI cables shall be available with optional universal locking kit for adapting to a wide range of HDMI connector overmold sizes. Locking kit shall include both M3X0.5 and 40-40UNC screws.

F. Approved Products:

1. Leviton QuickPort HDMI® pass-through connector, 40834-00W
2. Leviton QuickPort USB A-A pass-through connector, 40835-00W
3. Leviton High-Speed HDMI® Cables with Ethernet, 41900-0*E (* = 3, 6, 10 or 15 ft length)
4. HDMI cable lock kit, 41900-LKT

2.22 AUDIO VISUAL ENCLOSURES

A. STRUCTURED MEDIA CABINET (STRUCTURED MEDIA CENTER)

1. The Structured Media Center (SMC) terminates home-run wires from ceiling, wall, conference room tables, and Audio-Visual device locations, and provides a mounting location for electronics dedicated for Audio-Visual and related systems, or for use as an enclosure in Consolidation Point, MUTOA, and PON applications.
2. The SMC can be recessed-mounted between wall studs for a clean and professionally finished appearance. Smaller SMCs can be installed and concealed above ceiling or behind a flat-screen display for supporting home, classroom, and small office technologies and IT/AV control applications.
3. SMC shall be cULus Listed and meet all applicable standards:
 - a. ANSI/UL 1863 – Communication Circuit Accessories
 - b. CAN/CSA C22.2 No. 182.4-M90 (R2010) – Plugs, Receptacles, and Connectors for Communication Systems
 - c. TIA standards: ANSI/TIA-568-C, ANSI/TIA-570-B and ANSI/TIA-607
 - d. FCC part 68.
 - 1) The SMC shall be a one-piece (excluding cover) box, made of 20-gauge, white powder-coated steel. It shall flush-mount with four screws (provided) on standard 16" center wall studs prior to dry wall.
 - 2) The SMC shall be available in 14", 21", 28" and 42".
 - 3) Configuration and key features to include:
 - (a) Cutout pattern in bottom accommodates single gang or full width AC power modules and Mini and Universal DC power supplies
 - (b) Mounting slots on the enclosure simplify adjustment for different drywall depths (1/2 inch, 5/8 inch, and 3/4 inch)
 - (c) Lance slots provide clean cable management within the enclosure
 - (d) Product may be surface or recess mounted
 - (e) Ships with a cardboard insert to help prevent drywall debris or paint overspray from entering the enclosure during the rough-in stage of installation
 - (f) Keyhole slots on the cover allow for easier installation
 - (g) Multiple knockouts on the top and bottom support conduit up to two inches in diameter and facilitate cable routing and entry
 - (h) Self-healing foam grommets protect cable bundles
 - (i) Holds quarter, half, and full-width expansion modules, with the ability to mount most modules vertically or horizontally
 - (j) Mounting brackets (sold separately) can accommodate an array of devices
 - 4) 14-inch enclosure includes optional ceiling-mount kit for installing in non-plenum drop-ceiling applications.
 - 5) Structured Media Enclosure Dimensions:
 - (a) 14" Enclosure, 14.0" H x 14.38" W x 3.63" D
 - (b) 21" Enclosure, 21.10" H x 14.38" W x 3.63" D
 - (c) 28" Enclosure: 28.16" H x 14.3" W x 3.63" D
 - (d) 42" Enclosure: 42.16" H x 14.3" W x 3.63" D
 - (e) 14" Ceiling-Mount Kit, .75" H x 23.68" W x 23.68" D
 - 6) Approved Products
 - (a) Leviton 14" Enclosure only, 47605-14E
 - (b) Leviton 21" Enclosure only, 47605-21E
 - (c) Leviton 28" Enclosure only, 47605-28N
 - (d) Leviton 42" Enclosure only, 47605-42N
 - (e) Leviton 14" Ceiling-Mount Kit, 47612-CMK

B. STRUCTURED MEDIA DOOR

1. Door is typically not required when mounted behind LCD panel which will cover the SMC.
2. Structured Media Center Door shall be made of 18-gauge white powder-coated steel.
3. Door shall be vented to allow for the use of active equipment, and shall allow for a cylinder lock and key (sold separately).
4. Door shall have a fully concealed hinge which allows for 180-degree swing-out opening, and shall have left or right mounting options for the same part number with no additional accessories required.
5. Optional 2" extender bracket shall be available for 28- and 42-inch enclosures to increase depth between enclosure and door. Extender bracket shall overlap the enclosure and conceal minor variations in drywall cutout gaps.
6. Routing of cables shall be within wall and behind door. No cables shall pass through door.
7. Hinged Door Dimensions:
 - a. 14" Door, 15.32" H x 15.62" W x 0.25" D
 - b. 21" Door, 22.35" H x 15.62" W x 0.25" D
 - c. 28" Door, 29.32" H x 15.62" W x 0.25" D
 - d. 42" Door, 43.33" H x 15.62" W x 0.25" D
8. Approved Products
 - a. Leviton Premium Vented Door, 14", 47605-14S
 - b. Leviton Premium Vented Door, 21", 47605-21S
 - c. Leviton Premium Vented Door, 28", 47605-28S
 - d. Leviton Premium Vented Door, 42", 47605-42S
 - e. Structured Media Center Lock & Key, 5L000-L0K

C. STRUCTURED MEDIA CENTER MOUNTING BRACKETS

1. MODULAR CONNECTOR MOUNTING BRACKET
 - a. The modular jack mounting bracket can be used to hold modular connectors in place. It shall be constructed of black polycarbonate and allow for cable management routing under the bracket.
 - b. The modular jack mounting bracket shall accept up to twelve (12) modular jacks with any combination of data, video, audio or voice lines, including CAT 6A, 6 or 5e, HDMI, USB, F-Connector, BNC, S-Video, RCA, Fiber, and traditional telephone connectors.
 - c. Bracket may be positioned horizontally or vertically to accommodate for cable routing. Included port numbering label insert facilitates administrative changes and application designations.
 - d. Approved Products
 - 1) Leviton 12-Port QuickPort Mounting Bracket, 47600-QPB
2. UNIVERSAL MOUNTING PLATES
 - a. Universal Mounting Plates are the preferred method of securing a variety of extenders, power supplies and other devices into the SMC.
 - b. Made of white powder-coated 18-gauge sheet metal, and available in 6" or 12" (hole-to-hole) lengths.
 - c. " wide plates stand off from back of SMC and allow for wrap-around support/mounting straps to accommodate a wide variety of 3rd party device mounting options.
 - d. Universal Plates come in Half-Width and Full-Width sizes, and allow for ad-hoc mounting of electronic components, cord coils, IT/AV, networking and/or security products into SMC enclosures.

- e. Universal Security Plates come with four adhesive-backed PC board mounting clips to easily mount the widest range of security alarm and PC board panels, and four pushlock pin mounts ensuring both vertical and horizontal stability in the SMC backplane.
 - f. Approved Products
 - 1) Leviton Universal Security Plate, 6" (Half width), 47612-HSB
 - 2) Leviton Universal Security Plate, 12" (Full width), 47612-FSB
 - 3) ELECTRONIC DEVICE MOUNTING BRACKET
 - 4) Data Plastic Bracket can be used to mount extenders, switchers, splitters and other devices within the Structured Media Cabinet.
 - 5) The Data Plastic Bracket shall be constructed of sturdy white ABS plastic, and include four (4) pushlock pins and grommets for snap-in installation mounting into pre-drilled SMC hole patterns.
 - 6) Bracket shall allow 1.5" underneath for cable management
 - 7) Universal screw holes accept a variety of screw configurations, and mounting slots for easy fastening of routers, switches, etc.
 - g. Approved Products
 - 1) Leviton Data Plastic Bracket, 47612-DBK
- D. MOUNTING ACCESSORIES
1. Additional push-lock pins shall be available separately to enable mounting of non-standard mounting products or for repair and maintenance. Use to replace any broken push pins or grommets during installation to ensure all mounts are securely fastened to Cabinet.
 2. VELCRO Soft Cinch Lite® Wraps are ½" wide and ultra-flexible for light duty such as dressing and bundling cords in tight areas.
 3. Approved Products
 - a. Leviton Push-Lock Pins, bag of 20, 47615-NYL
 - b. Leviton 75' Soft Cinch Lite Roll by VELCRO, black, 4S115-75E
- E. SURGE PROTECTED RECEPTACLE KIT
1. Surge protective AC Power Modules and J-Box kits shall fit in a recessed-mount configuration in the bottom of the SMC. The surge protected receptacles provide EMI/RFI filtering that meets UL 1449 standards.
 2. The Dual AC Power Module features two 15-Amp duplex. J-Box Surge Protective Kit features one 15-Amp duplex receptacle, Receptacles shall be Blue in color, include EMI/RFI filtering, and shall have an audible alarm which signals an excessive power surge and that the unit is now operating unprotected against further surges
 3. The AC Surge Module provides six staggered NEMA 5-15P receptacles and allows six AC/DC plug-in power adapters to fit into the bottom of the SMC. The module effectively powers routers, switches, modems, volume controls, camera hubs, and other active gear mounted in the enclosure when transformers may otherwise block the unused adjacent outlet in a dual receptacle.
 4. Shall comply with UL1449, UL 1863, and CSA Certified.6-outlet module shall meet or exceed cULus (UL 1950 & CSA Equivalent), and IEC 60950-1.
 5. Enclosure material shall be powder-coated steel.
 6. Approved Products
 - a. Leviton Dual AC Power Module with Surge Protection, 47605-0DP
 - b. Leviton Single-gang J-Box Surge Protective Kit, 47605-ACS
 - c. Leviton AC Surge Module with 6 receptacles, 48212-06S

PART 3 – EXECUTION

3.1 ADDITIONAL INFORMATION

- A. Refer to Section 27 00 00 for the following Part 3 - Execution information
 - 1. General
 - 2. Cable Pathways
 - 3. Work Area Outlets
 - 4. Installation Practices
 - 5. Labeling
 - 6. Firestopping
 - 7. Sealing of Penetrations and Openings
 - 8. Cable Supports
 - 9. Cable Protection
 - 10. Grounding
 - 11. Testing
 - 12. Documentation
 - 13. Training
 - 14. Cleaning
 - 15. Project Closeout
- B. Structured Media Cabinets
 - 1. Structured Media Enclosures shall be installed as per the requirements specified by the manufacturer's installation guidelines and best industry practice
 - 2. Structured Media Enclosures shall be installed in accordance with the recommendations made in the TIA-570-B and TIA-568-C standards.
 - 3. Structured Media Enclosures shall be bonded and grounded in accordance with the recommendations made in the TIA-607-B standard
 - 4. Surge protected receptacles shall be installed by the Electrical Contractor.
 - 5. Utilize all appropriate mounting hardware for all devices and cables mounted within cabinet. No dangling or unsecured items will be acceptable. See detail sheets and refer questions to Owner or Owners Representative prior to or during installation.

3.2 AUDIO VISUAL DEVICES AND ACCESSORIES

- A. HDBASE-T DEVICES
 - 1. Follow manufacturer's user's manual for proper installation.
 - 2. One DC 24V power adaptor is required and can be attached at either end as the other can be energized via the PoH function of the interconnecting twisted pair cable.
 - 3. For best performance, Category 6A (isolation wrap or shielded) twisted pair cable should be installed in accordance with applicable ANSI/TIA-568-C standards and be field certified to 500 MHz using approved testers.
 - 4. Properly secure HDMI cables to devices with lock kit brackets and tie wraps.
 - 5. Installation methods shall adhere to NFPA National electrical code and all local building and fire codes.
- B. STANDARD AV EXTENSION DEVICES
 - 1. Follow manufacturer's instruction sheet for proper installation and adjustment.
 - 2. For best performance, Category rated twisted pair cable should be installed in accordance with applicable ANSI/TIA-568-C standards and be field certified using approved testers.
 - 3. Install DC power adaptor(s) as required.
 - 4. Properly secure all cables with appropriate strain relief methods.
 - 5. Installation methods shall adhere to NFPA National electrical code and all local building and fire codes.

C. MIXING AUDIO AMPLIFIERS

1. Follow manufacturer's instruction sheet for proper installation and sound level adjustment.
2. Install DC power adaptor(s) as required.
3. Properly secure all cables with appropriate strain relief methods.
4. Installation methods shall adhere to NFPA National electrical code and all local building and fire codes.

3.3 CABLING

A. CAT6A STRUCTURED CABLING CHANNELS

1. Cabling shall be installed in accordance with manufacturer's recommendations and best industry practices.
2. Cables shall be installed in continuous lengths from origin to destination (no splices).
3. Shielded cabling channels shall include appropriate method of bonding shield to approved ground for proper EMI/RFI mitigation.
4. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
5. Cable supports shall be self-supporting and utilize independent wires, support rods and associated hardware for suspension. At no point shall cable(s) rest on acoustic ceiling grids, T-bars, ceiling support wires, acoustical panels or other components of the suspended ceiling.
6. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
7. 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.
8. When cables are being installed, slack (service loops) shall be provided at both ends to accommodate future changes in the structured cabling system.
9. Each cable shall be clearly labeled on the cable jacket behind the termination device
10. 100 percent of cabling channels shall be tested to meet or exceed ISO/IEC Class EA and TIA Category 6A performance parameters.
11. Defects in cabling system installation, including but not limited to cables, connectors, patch panels, and connector blocks shall be repaired or replaced to ensure 100 percent useable conductors in all cables installed.
12. Shield Continuity Testing shall be Enabled when shielded cabling channels are installed.
13. Provide test results in approved certification testers original software format on CD.

B. HDMI CABLES

1. Follow manufacturer's instruction sheet for proper installation
2. Secure HDMI cables to active device ports with cable locking kits or industry best practice to mitigate inadvertent cable disconnects.

3.4 TESTING

- A. Contractor shall engage a factory representative to provide functional testing of the Audio Visual System. Representative shall identify any deficiencies in the systems and corrective actions shall be taken by the contractor to provide the owner with a fully functional system.
- B. Testing shall include, at a minimum:
 1. All equipment noted in this section to ensure proper installation and functionality
 2. Cabling and terminations, to ensure continuity of wiring and fidelity of connections
 3. Controls operations

- a. Volume Controls
- b. Input Controls
- c. Streaming/Recording Controls
- d. Other operations required for the equipment noted in this section

3.5 TRAINING

- A. Contractor shall engage a factory representative to provide training to Owner's staff and personnel. Factory representative shall provide a minimum of (4) hours of training and shall cover the following topics:
 1. Equipment operations and maintenance requirements
 - a. Proper method for software / Firmware upgrades
 - b. Maintenance for fans and other equipment as may be required
 2. Equipment functionality, including:
 - a. Proper operation of streaming/recording equipment
 - b. Proper operation of control panels
 - c. Proper operation of rack mounted equipment

3.6

END OF SECTION

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SECTION 27 41 16.06
ASSISTIVE LISTENING SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

- A. Furnish and install all materials and equipment including all required equipment and connectors, and provide all labor required and necessary to complete the work shown on the drawings and/or specified in all Sections of Division 27 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete assistive listening system. It is the intent of the drawings and specifications that the system be complete, coordinated with the existing local sound system, and ready for operation.

1.2 RELATED WORK:

- A. 27 05 00 General Requirements for Communications Systems
- B. Refer to the General Conditions, Supplementary General Conditions, and Division 1 General Requirements.

1.3 CODES AND STANDARDS:

- A. Devices and equipment for the local public address system shall be listed by U.L. for the specific purpose the device or equipment is used.
- B. Work and material shall be in compliance with and according to the requirements of the latest revision of the following standards and codes:
 - 1. 2019 Building Standards Administrative Code, Part 1, Title 24 California Code of Regulations (C.C.R.)
 - 2. 2019 California Building Code (CBC), Part 2, Title 24 C.C.R. - 2018 International Building Code and California Amendments
 - 3. 2019 California Electric Code (CEC), Part 3, Title 24 C.C.R. - 2017 National Electric Code and California Amendments

1.4 SUBMITTALS:

- A. In accordance with Section 27 05 00.
- B. Submit the following items:
 - 1. Manufacturer's Catalog Data: Manufacturer's original catalog cuts or original description of data of all material and equipment with sufficient information provided so that the exact function of each device is known.
 - 2. Maintenance manuals and part lists. Manual shall include schematic drawings and service instructions. All parts shall be identified with standard part numbers and electrical characteristics, which can be recognized by Owner's maintenance technicians.

1.5 SUBSTITUTIONS:

- A. If substitutions are proposed, the Contractor shall show by "proof of performance" test that the substitute equipment is equal or superior to the equipment specifications, to the satisfaction of the Owner. This proof shall be shown by actual tests and not through printed literature. The Contractor shall provide qualified audio technicians and such test equipment as required to perform this test.
 - 1. The cost of proof of performance tests shall be borne by the contractor and not included as part of the Contract.

1.6 WARRANTY:

- A. The transmitter and receiver shall have a 5 year warranty on parts and labor.

1.7 QUALIFICATIONS OF INSTALLER:

- A. Prior to installation, submit data for review showing that the contractor has at least 3 years experience successfully installed assistive listening systems of similar type and design, or that there is a contractual agreement with a subcontractor having related experience.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION:

- A. General: The system shall provide for portable, wireless, FM based local distribution of voice and music from the local sound system through the assistive listening system to wireless stereo receivers with headsets. The system shall be portable and of modular design to facilitate expansion and shall be completely solid state.
 - 1. Work included in this Section: Complete wireless assistive listening system Including but not limited to the following:
 - a. Digital Wireless Transmitter
 - b. Wireless Stereo Receivers with Headsets
 - c. Charger and Carrying Case
 - d. Test, operational check and demonstration of system operation

2.2 ASSISTIVE LISTENING SYSTEM:

- A. The Assistive Listening System shall consist of a single transmitter personal receivers. Provide personal receivers with rechargeable batteries and interface with existing local sound system. Provide a purpose made carrying case and battery recharger.
- B. Transmitter:
 - 1. Transmitter shall have an “on” indicator, a power button, push button control for monitoring source audio or transmitted audio and an input overload indicator.
 - 2. Transmitter shall be microprocessor controlled with push button LCD digital configuration of:
 - a. Bandwidth
 - b. Frequency
 - c. Audio Input Source (Microphone, Line, Simplex)
 - d. High Pass Filter
 - e. Low Pass Filter
 - f. Compressor Slope
 - g. Compressor Gain
 - h. RF Output Power
 - 3. The audio level shall be adjustable by push button control via a 10 LED array showing +9 to -18dB at 3dB intervals.
 - 4. Transmitter shall have an operating range of up to 1000 feet.
 - 5. Transmitter shall have 17 wideband channels and 40 narrowband channels operating on 72.025–75.975 MHz.
 - 6. Transmitter shall have three pre-configured (selectable) application presets:
 - a. Hearing Assist
 - b. Music
 - c. Voice
 - 7. Transmitter shall have a 1/4" phone jack with push button volume control.
 - 8. Transmitter shall be powered by an in-line 120VAC-to-12VDC power supply via a barrel type connector.
 - 9. Transmitter shall have a 75 ohm F-connector whip antenna on the top panel directly connected to the circuit board.

10. The transmitter shall have an RCA line output jack and a combination 1/4" phone/XLR audio input jack. It shall have an RF "Off" timer that turns off RF signal after 1 hour of no audio activity.
 11. The transmitter shall be approved by the Federal Communications Commission (FCC) and be powered by a UL-approved wall transformer.
 12. Manufacturer: Listen Technologies LT-800-072-01 Stationary RF Transmitter or approved equal. Provide with the following accessories from the same manufacturer:
 - a. (1) LA-122 Universal Antenna Kit
 - b. (1) LA-326 Universal Rack Mounting Kit
 - c. (1) LPT-A107-B Dual RCA to Dual RCA Cable
 - d. (1) LA-304 Assistive Listening Notification Signage Kit
- C. Wireless Stereo Receivers:
1. Provide twelve (12) wireless stereo receivers.
 2. The receiver shall be tunable to any one of 17 preset wideband channels or 40 narrowband channels within 72.025 – 75.950 MHz via a seek button located inside the battery compartment. The receiver shall have channel lock capability.
 3. The receiver shall have an on/off switch and volume control, which adjusts the output level as required by the listener.
 4. The receiver shall include an indicator light that lights when the power is on and flashes when the battery is low.
 5. The receiver shall be capable of operating for up to 8 hours per charge and shall be powered by a rechargeable Lithium Ion battery. The unit's battery shall be recharged via micro-USB connector.
 6. The receiver shall be FCC approved.
 7. The receiver shall have two 3.5mm stereo output jack, which accepts any one of the manufacturer's accessories.
 - a. Provide one (1) standard stereo headset per receiver, or a minimum of two headsets.
 - b. Provide one (1) additional neckloop induction loop to transfer sound signals directly to a hearing aide equipped with a T-coil for 25% of receivers, or a minimum of two neckloops.
 8. Manufacturer: Listen Technologies LR-5200-072 Advanced Intelligent DSP RF Receiver or approved equal. Provide with the following accessories from the same manufacturer:
 - a. (12) LA-401 Universal Ear Speaker
 - b. (3) LA-430 Intelligent Earphone/Neck Loop Lanyard
- D. Charger and Carrying Case:
1. Each charger shall be drop and style, capable of recharging up to 12 receivers equipped with Litium Ion batteries at once. Provide quantity of chargers to accommodate all receivers noted above.
 2. The charging circuitry must be fully automatic. The charger shall be microprocessor controlled, timed recharge. Once the timer has completed its charging cycle, the charger shall provide a maintain charge. The charger must be capable of recharging Lithium Ion batteries without removal from the receiver.
 3. Each bay on the charger shall have a red LED indicating charging status. The LEDs shall be on constantly during charging and will blink indicating batteries are fully charged.
 4. The charger shall be powered by an external switching power supply (100-240 VAC input; 5 VDC, 8A output) via a CD barrel connector.
 5. Charger shall be enclosed in black, impact resistant, ABS plastic.
 6. The carrying case shall have a large, foam-lined storage space for accessories, a locking lid, and a handle. The case shall have a pocket to contain the power wall transformer during storage.

7. Manufacturer: Listen Technologies LA-381-01 Intelligent 12-Unit Charging Tray or approved equal.

2.3 WIRES AND CABLES:

- A. Provide all required interconnection cables and required connectors.
- B. All interconnection cables shall be professional type with very low impedance and gold contact connectors.

PART 3 EXECUTION

3.1 INSTALLATION AND WORKMANSHIP:

- A. All components shall be assembled, installed and tested by a Contractor specializing in communications systems.
- B. The Contractor shall take such precautions as are necessary to guard against electromagnetic and electrostatic hum and to install the equipment so as to provide maximum safety to the person who operates it.

3.2 TESTS:

- A. The Contractor shall perform an operational check to assure that the system complies with all requirements of these specifications. Operation tests shall be made in the presence of the Owner's representative, who shall be notified of the test date a minimum of ten (10) days prior to that date.
- B. The Contractor at no additional cost to the Owner shall replace any system, material or equipment found to be defective.
- C. Provide 1 hour of training to Owner to demonstrate system function.

END OF SECTION