# CSD - CVHS FIBER BACKBONE REPLACEMENT PIVOT ARCHITECTURE PROJECT NO. 1832.02

PROJECT MANUAL - VOLUME 2 OF 2 SPECIFICATIONS DIVISIONS 21 - 33

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- NOT USED -

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- NOT USED -

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- NOT USED -

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- NOT USED -

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- NOT USED -

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- NOT USED -

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- NOT USED -

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#### ARCHITECTURE – Division 01-14:

PIVOT Architecture 44 West Broadway, Suite 300 Eugene, OR 97401 Tel: 541.342.7291 www.pivotarchitecture.com

#### PLUMBING/MECHANICAL – Div. 21-23:

Systems West Engineers, Inc. 725 A Street Springfield, OR 97477 Tel: 541.342.7210 www.systemswestengineers.com.

#### ELECTRICAL – Div. 26:

Systems West Engineers, Inc. 725 A Street Springfield, OR 97477 Tel: 541.342.7210 www.systemswestengineers.com.

#### COMMUNICATIONS/ELECTRONIC SAFETY AND SECURITY – Div. 27-28:

#### NIS 4900 SW Griffith Drive, # 250

Beaverton, OR 97005 Tel: 503.246.8585 www.NIS.consulting.com

## END OF DOCUMENT 00 0107









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## SECTION 21 1313 - WET-PIPE SPRINKLER SYSTEMS

## PART 1 - GENERAL

#### 1.1 SUMMARY

A. Fire sprinkler system modifications to existing wet-pipe fire suppression system where indicated on Drawings.

#### 1.2 DESIGN REQUIREMENTS

- A. Fire suppression system modifications shall comply with the rules, regulations, and ordinances of the Authority Having Jurisdiction and the following referenced standards:
  - 1. NFPA 13 Standard for Installation of Fire Sprinkler Systems
- B. Hazard Classifications: As defined by NFPA 13 and by Authority Having Jurisdiction.

#### 1.3 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Pipe and fittings	Х							Х

- B. Special Requirements:
  - 1. Product Data: Submit manufacturer's technical literature and installation instructions for products and materials.
  - 2. Fabrication Drawings: Prepare scaled drawings for fire protection piping, heads, valves, and accessories including pipe sizes, locations, elevations, slope of horizontal runs, wall and floor penetrations and connections.
  - 3. Submittal Process:
    - a. Submit preliminary drawings showing sprinkler layout, including exposed piping to Architect for review.
    - b. Upon approval by Architect, submit drawings to Authority Having Jurisdiction.
    - c. Upon approval by Authority Having Jurisdiction, submit final drawings with approval stamp to Architect.

4. Certificate of Installation: Submit certification upon completion of fire protection piping work confirming that the work was tested in accordance with NFPA 13, and that the system is fully complete and operational.

## 1.4 QUALITY ASSURANCE

A. The system designer shall be responsible for verifying site conditions, design requirements, and work being performed by other trades as related to the suppression system design. Design shall accommodate work being performed by other trades. Contractor shall identify areas of the building which will be subject to freezing.

## 1.5 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions:
  - 1. Notify Construction Manager no fewer than five days in advance of proposed interruption of sprinkler service.
  - 2. Do not proceed with interruption of sprinkler service without Construction Manager's written permission.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. All products shall be UL listed and FM approved

## 2.2 STEEL PIPE AND FITTINGS

- A. Automatic Fire Sprinkler (F), above grade:
  - 1. Black steel. ASTM A-135, Grade B, black, schedule 10 steel pipe or ASTM A53 Type E, Grade B, black, schedule 40 standard weight steel pipe.
  - 2. Weight: Schedule as required in NFPA No. 13.
  - 3. Fittings: Threaded, malleable iron threaded, 150 lb. ANSI B16.3 or mechanical joint, ASTM 47.

## 2.3 SPRINKLERS

- A. General:
  - 1. UL Listed and FM approved.
  - 2. Provide temperature rating in accordance with NFPA 13.
- B. Acceptable Manufacturers: Standard, Tyco, Viking, Reliable Automatic Sprinkler Co.., Inc or approved.
- C. Upright:
  - 1. Finish: Exposed, standard chrome head and escutcheon; concealed, standard brass.

2. Application: Exposed piping and concealed spaces.

## D. Wet Pendent:

- 1. Finish: Exposed, standard chrome; concealed, standard brass.
- 2. Application: Exposed piping and concealed spaces.

## E. Sidewall:

- 1. Finish: Exposed, standard chrome; concealed, standard brass.
- 2. Application: Exposed piping and concealed spaces.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Drawings show approximate locations of sprinkler piping and heads.
- B. Install pipe parallel to building structural system and in a neat and professional manner.
- C. Provide seismic bracing as required by NFPA and Authority Having Jurisdiction.

## 3.2 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

## 3.3 TESTS

- A. Perform tests as required by Authority Having Jurisdiction.
- B. Perform hydrostatic of all piping at 125 psi or 50 psi above system static pressure and maintain for four hours.
- C. Provide duplicate test certificates and approvals by the Authority Having Jurisdiction to Architect.

## 3.4 RECORD DRAWINGS

A. Provide as-built drawings in accordance with Division 1.

## END OF SECTION 21 1313

## SECTION 22 0500 - GENERAL PLUMBING PROVISIONS

#### PART 1 - GENERAL

#### 1.1 CONTRACT DOCUMENTS

- A. General plumbing provisions apply to all work performed in Division 22.
- B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.
- C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.
- D. Particular attention is called to Instructions to Bidders, General Conditions, Drawings and Specifications, and modifications incorporated in the documents before execution of the Agreement.
- E. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Architect/Engineer and Owner's Authorized Representative prior to fabrication.
- F. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

#### 1.2 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): The governmental agency or sub-agency which regulates the construction process.
- B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

## 1.3 COORDINATION

- A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and secure written approval and agreement on necessary adjustments before start of work.
- B. Architectural drawings govern all other drawings. Consult in detail the door swings, counter heights and similar items affecting work before rough-in.

#### 1.4 SUBMITTALS AND SHOP DRAWINGS

- A. See Section 01 3000 "Administrative Requirements."
- B. Action Submittal Content

- 1. Action submittal information not expressly required by the specifications will not be reviewed.
- 2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
- 3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
- 4. Action submittal requirements will be listed in individual specification sections. The following definitions apply.
  - a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
  - b. Catalog data: Manufacturer's standard product cut sheet.
  - c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.
  - d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
  - e. Wiring Diagrams: Power and control wiring diagrams.
  - f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
  - g. Installation Instructions
  - h. Special Requirements Listed: Additional requirements indicated in individual specification sections.

## 1.5 QUALITY ASSURANCE

- A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.
- B. Asbestos products or equipment or materials containing asbestos shall not be used.

## 1.6 DESIGN REQUIREMENTS

- A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.
- B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

#### 1.7 CODES AND STANDARDS

- A. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.
- B. Work shall comply with the Americans with Disabilities Act (ADA).

#### 1.8 TEMPORARY SERVICES

- A. Provide in accordance with Section 01 5000 "Temporary Facilities and Controls" as required for completion of work. Provide additional filters as required to keep areas clean during construction
- B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

#### 1.9 OPERATIONS AND MAINTENANCE MANUALS

- A. Provide manuals as noted in Section 01 7800 "Closeout Submittals," clearly indexed and bookmarked for each item or product. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each. Index tabs shall match submittal schedule and include any additional information required for operations and maintenance, whether in submitted schedule or not.
- B. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.
- C. Provide copy of approved submittal for each product included in manual
- D. Provide printed copy and electronic configuration files for all packaged equipment control systems furnished with equipment.
- E. Mark the model actually provided where the literature covers more than one model. Include four copies of all submittal data corrected to "as-built" conditions within the manual.
- F. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.
- G. Manual Content: Manuals shall contain complete information for each item of plumbing electrical or other operating equipment. Include as applicable:
  - 1. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance
  - 2. Lubrication schedules
  - 3. Performance capacity
  - 4. Catalog data sheets
  - 5. Parts list

6. Maintenance schedules

#### 1.10 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Transfer all information to one hard copy of drawings at completion of project. Alternately, provide electronically using .pdf markup of contract drawings.

#### PART 2 - PRODUCTS

## 2.1 PRODUCTS AND MATERIALS

- A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.
- B. Equipment used as the basis of design is scheduled on drawings or designated in product specifications. If Contractor chooses to use equipment that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated plumbing and electrical systems needed to provide equal system performance and maintainability.

## 2.2 CLEANING SYSTEMS

A. General: After all equipment and pipes are installed, system shall be thoroughly cleaned. Remove all stickers and tags from equipment or fixtures. Clean all piping systems prior to installation of insulation or painting.

## 2.3 START UP

A. The Plumbing Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.

END OF SECTION 22 0500

## SECTION 22 0529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

#### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes hangers and supports for plumbing piping and equipment

#### 1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Supports for multiple pipes, including pipe stands, shall be capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

## 1.4 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 22 0500 – General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Detailed Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein

PRODUCT TABLE	1	2	3	4	5	6	7	8
Pipe Hangers and Supports		Х						
Thermal Hanger Shield Inserts		Х						

## 1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

#### 2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
  - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:
  - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
  - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

## 2.2 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. B-line, an Eaton business.
    - b. Thomas & Betts Corporation; A Member of the ABB Group.
    - c. Unistrut; Part of Atkore International.
  - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
  - 3. Standard: MFMA-4.
  - 4. Channels: Continuous slotted steel channel with inturned lips.
  - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
  - 7. Metallic Coating: Hot-dipped galvanized.

#### 2.3 INSULATION INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. National Pipe Hanger Corporation.
  - 2. Pipe Shields Inc.
  - 3. Insulshield
  - 4. Uni-Grip
- B. General: Insulation insert for use with MSS Type 40 protection saddle.

- C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## PART 3 - EXECUTION

## 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
  - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

## I. Insulated Piping:

- 1. Piping Operating Below Ambient Air Temperature:
  - a. Provide Insulation Insert with MSS Type 40 protection shield.
- 2. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
- 3. Insulation Inserts: Same thickness as piping insulation.

## 3.2 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

## 3.4 HANGER SPACING

А.

PLUMBING PIPING SPACING	Maximum Horizontal	Maximum Vertical Spac-		
TABLE	Span	ing		
Carbon Steel				
1-1/4 inch and smaller	7 feet	15		
Copper Tubing				
<sup>3</sup> / <sub>4</sub> inch and smaller	5 feet	10		
1 inch to 2 inch	7 feet	10		

## 3.5 ROD SIZES

- A. Select rod diameter to not exceed the maximum safe load listed in Table 2 of MSS SP-58-2009.
- 3.6 HANGER AND SUPPORT SCHEDULE
  - A. Single Pipe, Hung and Uninsulated
    - 1. NPS 1/2 to NPS 3: Adjustable Steel Band Hanger, MSS Type 7.
  - B. Single Pipe, Hung and Insulated
    - 1. Operating Temperature Less Than Ambient: Steel Clevis, MSS Type 1
  - C. Multiple Pipe Trapeze or Pipe Rack: Trapeze Hanger, MSS Type 59.
    - 1. Uninsulated Piping: Steel Strap.
    - 2. Insulated Piping: Adjustable Roller, MSS Type 43.
  - D. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
  - E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
  - F. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
  - G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
  - H. Use padded hangers for piping that is subject to scratching.
  - I. To eliminate the need for seismic restraint, for piping installation where the distance from the top of the pipe to the structure is 12 inches or less for the entire run, select hanger-rod and building attachments to allow pipe movement without stress on hangers and attachments.
  - J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
    - 2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
    - 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
    - 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F piping installations.
  - K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
    - 2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.

- 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F piping installations.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications.
- N. Comply with MFMA-103 for metal framing system selections and applications.

END OF SECTION 22 0529

## SECTION 22 0553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Pipe labels.
  - 2. Valve tags.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

## 1.3 COORDINATION

A. Coordinate with Division 23. Match manufacturer, type, and style of identification used.

## PART 2 - PRODUCTS

## 2.1 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

#### 2.2 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: aluminum, 0.025-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

#### PART 3 - EXECUTION

## 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

## 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment. Label ceilings or ceiling grid (not the tile) to indicate key access points for equipment, valves, and other components requiring quick access or routine maintenance. Provide a clear adhesive label and bold black lettering with equipment and valve identification information.

#### 3.3 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device
  - 2. Near each flange
  - 3. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch
  - 4. Near penetrations through walls, floors, ceilings, and inaccessible enclosures
  - 5. At access doors, manholes, and similar access points that permit view of concealed piping
  - 6. Near major equipment items and other points of origination and termination

- 7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule: Letter and background color in accordance with ANSI A13.1.
- 3.4 VALVE-TAG INSTALLATION
  - A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
  - B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
    - 1. Valve-Tag Information. Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch valve tag numbers.

END OF SECTION 22 0553

## SECTION 22 0719 - PLUMBING PIPING INSULATION

#### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes insulating plumbing piping services:

#### 1.2 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 22 0500 – General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Insulation Materials		Х						Х
Field Applied Jackets		Х						Х

- B. Special Requirements
  - 1. Product Data: For each type of insulation product listed, provide thermal conductivity and water-vapor permeance.

#### 1.3 QUALITY ASSURANCE

- A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.4 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 0529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

#### 1.5 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

#### PART 2 - PRODUCTS

- 2.1 INSULATION MATERIALS
  - A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
  - B. Products that come in contact with stainless-steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
  - C. Insulation materials for use on austenitic stainless-steel shall be qualified as acceptable according to ASTM C 795.
  - D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
  - E. Mineral-Fiber, Preformed Pipe Insulation:
    - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. Johns Manville; a Berkshire Hathaway company.
      - b. Knauf Insulation.
      - c. Manson Insulation Inc.
    - 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factoryapplied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.

## 2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180°F.
  - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 4. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
  - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  - 2. Service Temperature Range: Minus 50 to plus 220°F.
  - 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  - 4. Color: White.

#### 2.4 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  - 1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

#### 2.5 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 11.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  - 1. Width: 2 inches.
  - 2. Thickness: 6 mils.
  - 3. Adhesion: 64 ounces force/inch in width.
  - 4. Elongation: 500 percent.
  - 5. Tensile Strength: 18 lbf/inch in width.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

#### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- C. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- D. Install multiple layers of insulation with longitudinal and end seams staggered.
- E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.

- 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
- 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Cleanouts.
- P. Insulation Installation on Fittings, Valves, and Unions:
  - 1. Install insulation over fittings, valves, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

- 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
- 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
- 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
- 5. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- 6. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- Q. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- R. Install removable insulation covers at the following:
  - 1. Valves
  - 2. Mechanical couplings requiring access to allow equipment service.
- S. Install removable insulation covers at locations indicated. Installation shall conform to the following:
  - 1. Make removable union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  - 2. When union covers are made from sectional pipe insulation, extend insulation from unions at least two times the insulation thickness over adjacent pipe insulation on each side of union.

## 3.4 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
  - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

- 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- C. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

## 3.5 PIPING INSULATION THICKNESS

- A. General
  - 1. For piping smaller than 1-1/2 inches and located in partitions within conditioned spaces, reduction of thickness by 1-inch permitted to a thickness not less than 1-inch.
- B. Mineral Fiber Insulation

FIBERGLASS							
FLUID	NORMAL	NOMI	NAL PI	PE OR	TUBE	SIZE	
OPERATING		(inches)					
TEMPERATURE							
			1 to	1.5 to	4 to		
		<1	< 1.5	< 4	< 8	< 8	
105-140		1	1	1.5	1.5	1.5	
40-60		0.5	0.5	1	1	1	
<40		0.5	1	1	1	1.5	

## 3.6 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. For all systems with an operating temperature that may be below ambient conditions, a vapor barrier must be maintained.

## 3.7 INDOOR PIPING INSULATION SCHEDULE

- A. Base insulating thickness on operating temperature unless thickness is specifically listed in section below.
- B. Potable Cold-Water Piping: Normal operating temperature 50°F.
  - 1. Mineral-Fiber, Preformed Pipe Insulation, Type I.

# END OF SECTION 22 0719

## SECTION 22 1116 - DOMESTIC WATER PIPING

## PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes pipe, fittings, joining methods, valves, and trap primer systems for potable water piping.

#### 1.2 PERFORMANCE REQUIREMENTS

A. All potable water plumbing piping, equipment, fittings, and accessories shall be capable of withstanding a maximum pressure of 125 psi and a maximum temperature of 140°F. Exceptions would include specific items of equipment where a lower operating pressure is specified.

## 1.3 ACTION SUBMITTALS

- A. Provide materials list for pipe and fittings.
- B. Provide catalog data for dielectric fittings.
- C. Provide catalog data for ball valves.
- D. Provide catalog data for trap primer system.
- 1.4 INFORMATIONAL SUBMITTALS
  - A. System purging and disinfecting activities report.
- 1.5 FIELD CONDITIONS
  - A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
    - 1. Notify Owner no fewer than five days in advance of proposed interruption of water service.
    - 2. Do not interrupt water service without Owner's written permission.

#### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- B. Comply with NSF Standard 372 for low lead.

## 2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Copper Unions:
  - 1. MSS SP-123.
  - 2. Cast-copper-alloy, hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal seating surfaces.
  - 4. Solder-joint or threaded ends.

## 2.3 PIPING JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys.
- B. Flux: ASTM B 813, water flushable.
- C. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for generalduty brazing unless otherwise indicated.
- 2.4 BALL VALVES
  - A. NPS 3 and Smaller:
    - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. Conbraco Industries, Inc.
      - b. Hammond Valve.
      - c. Jenkins Valves; Crane Energy Flow Solutions.
      - d. Milwaukee Valve Company.
      - e. NIBCO INC.
      - f. Stockham; Crane Energy Flow Solutions.
    - 2. Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim:
      - a. Standard: MSS SP-110.
      - b. SWP Rating: 150 psig.
      - c. CWP Rating: 600 psig.
      - d. Body Design: Two piece.
      - e. Body Material: Bronze.
      - f. Ends: Threaded.
      - g. Seats: PTFE.
      - h. Stem: Bronze.
      - i. Ball: Chrome-plated brass or Stainless-steel.

j. Port: Full.

## 2.5 TRAP-SEAL PRIMER SYSTEMS

- A. Trap-Seal Primer Systems (TPA):
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Precision Plumbing Products.
    - b. Zurn Industries, LLC.
  - 2. Standard: ASSE 1044.
  - 3. Description: Electronic trap primer array with adjustable frequency and duration settings. Mounted in box with cover, inlet connection, full-port ball-type shut-off valve, wye strainer, transformer, copper internal piping, and multi-port manifold.
  - 4. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
  - 5. Cabinet: Steel box with stainless-steel cover.
    - a. Surface mounted: IDF room.
  - 6. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
    - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 7. Vacuum Breaker: ASSE 1001.
  - 8. Number of trap primers and number of outlets as required to serve all building trap primer connections.
  - 9. Size Outlets: NPS 1/2.

## PART 3 - EXECUTION

## 3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Install piping as indicated unless deviations to layout are approved by Engineer.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install domestic water piping level and plumb.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

- G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

## 3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

## 3.3 DIELECTRIC FITTING INSTALLATION

A. Provide screwed brass union or screwed brass valve where dissimilar metals meet.

## 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 22 0529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Support vertical piping and tubing at base and at each floor.
### 3.5 CONNECTIONS

- A. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- B. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- C. Connect domestic water piping to water-service piping with shutoff valve.
- D. Connect to equipment with pipe sizes indicated but not smaller than the size of the equipment connection.

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. Arrange for inspection in accordance with authority having jurisdiction.
    - c. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
  - 2. Piping Tests:
    - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
    - f. Prepare reports for tests and for corrective action required.
- B. Prepare test and inspection reports.

# 3.7 ADJUSTING

- A. Perform the following adjustments before operation:
  - 1. Open shutoff valves to fully open position.
  - 2. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.8 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
  - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    - d. Repeat procedures if biological examination shows contamination.
    - e. Submit water samples in sterile bottles to authorities having jurisdiction.

# 3.9 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
  - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

END OF SECTION 22 1116

### SECTION 22 1316 - SANITARY WASTE, VENT, AND STORM DRAIN PIPING

#### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes pipe, fittings, and joining methods for sanitary waste, vent and storm drain piping.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

#### 1.3 ACTION SUBMITTALS

- A. Provide materials list for pipe and fittings.
- B. Provide catalog data for dielectric fittings.
- 1.4 INFORMATIONAL SUBMITTALS
  - A. Field quality-control reports.

#### 1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
  - 1. Notify Owner's Authorized Representative no fewer than five business days in advance of proposed interruption of sanitary waste service.
  - 2. Do not proceed with interruption of sanitary waste service without written permission of Owner's Authorized Representative.

#### PART 2 - PRODUCTS

# 2.1 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

# 2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:

- 1. Standards: ASTM C 1277 and CISPI 310.
- 2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

# 2.3 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
  - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
  - 2. Unshielded, Non-pressure Transition Couplings:
    - a. Standard: ASTM C 1173.
    - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - c. End Connections: Same size as and compatible with pipes to be joined.
    - d. Sleeve Materials:
      - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      - 2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

# PART 3 - EXECUTION

### 3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved by Engineer.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.

- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
  - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
  - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - a. Straight tees, elbows, and crosses may be used on vent lines.
  - 3. Do not change direction of flow more than 90 degrees.
  - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Do not reduce size of waste piping in direction of flow.
- K. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
  - 1. Sanitary Waste: 2 percent downward in direction of flow, for piping NPS 3 and smaller.
  - 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- M. Install steel piping according to applicable plumbing code.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors.

#### 3.2 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
  - 1. Cut threads full and clean using sharp dies.
  - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    - c. Do not use pipe sections that have cracked or open welds.
- C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

# 3.3 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
  - 1. Install transition couplings at joints of piping with small differences in ODs.
  - 2. In Waste Drainage Piping: Non-pressure transition couplings. Unshielded above grade.

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 0529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Support vertical piping and tubing at base and at each floor.

### 3.5 CONNECTIONS

- A. Connect waste and vent piping to the following:
  - 1. Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
  - 2. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- B. Make connections according to the following unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### 3.6 FIELD QUALITY CONTROL

- A. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.

- 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
  - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
  - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
  - c. Inspect joints for leaks.
- 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
  - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
  - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
  - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
  - d. Inspect plumbing fixture connections for gas and water leaks.
- 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 6. Prepare reports for tests and required corrective action.

# 3.7 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### 3.8 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. All sanitary waste, storm water, and underground sanitary vent piping shall be the following:
  - 1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
  - 2. Dissimilar Pipe-Material Couplings: Non-pressure transition couplings.
- C. Aboveground, sanitary vent piping shall be any of the following:
  - 1. Galvanized-steel pipe, drainage fittings, and threaded joints.
  - 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
  - 3. Dissimilar Pipe-Material Couplings: Unshielded, Non-pressure transition couplings.

### END OF SECTION 22 1316

### SECTION 22 1319 - SANITARY WASTE AND STORM DRAINAGE PIPING SPECIALTIES

#### PART 1 - GENERAL

#### 1.1 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 22 0500 – General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products in this Section		Х						

#### 1.2 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

#### PART 2 - PRODUCTS

#### 2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

#### 2.2 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Hub Drains:
  - 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap with primer connection, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
  - 2. Size: Same as connected waste piping.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Assemble hub drain fittings and install with top of hub 2 inches above floor unless otherwise indicated.
- B. Install wood-blocking reinforcement for wall-mounting-type specialties.
- C. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

### 3.2 **PROTECTION**

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 1319

### SECTION 23 0500 - GENERAL HVAC PROVISIONS

#### PART 1 - GENERAL

- 1.1 CONTRACT DOCUMENTS
  - A. General HVAC provisions apply to all work performed in Division 23.
  - B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.
  - C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.
  - D. Particular attention is called to Instructions to Bidders, General Conditions, Drawings and Specifications, and modifications incorporated in the documents before execution of the Agreement.
  - E. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Architect/Engineer and Owner's Authorized Representative prior to fabrication.
  - F. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

#### 1.2 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): A federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.
- B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

### 1.3 COORDINATION

- A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and secure written approval and agreement on necessary adjustments before start of work.
- B. Architectural drawings govern all other drawings. Consult in detail the door swings, counter heights and similar items affecting work before rough-in.
- C. Coordinate identification systems with other trades. All mechanical systems shall use identical piping, valve, and equipment identification and regulatory signage.

### 1.4 SUBMITTALS AND SHOP DRAWINGS

- A. See Section 01 3000 "Administrative Requirements."
- B. Action Submittal Content
  - 1. Action submittal information not expressly required by the specifications will not be reviewed.
  - 2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
  - 3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
  - 4. Action submittal requirements are listed in individual specification sections. The following definitions apply.
    - a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
    - b. Catalog data: Manufacturer's standard product cut sheet.
    - c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.
    - d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
    - e. Wiring Diagrams: Power and control wiring diagrams.
    - f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
    - g. Installation Instructions
    - h. Special Requirements Listed: Additional requirements indicated in individual specification sections.
- C. Delegated Design
  - 1. Delegated work will include but is not limited to the following:
    - a. Section 23 0900 "Building Automation Systems for HVAC."
  - 2. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
    - a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

### 1.5 QUALITY ASSURANCE

- A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.
- B. Asbestos products or equipment or materials containing asbestos shall not be used.
- C. Certify that each welder has passed the American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

#### 1.6 DESIGN REQUIREMENTS

- A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.
- B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

#### 1.7 CODES AND STANDARDS

- A. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.
- B. Work shall comply with the Americans with Disabilities Act (ADA).

#### 1.8 TEMPORARY SERVICES

A. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

#### 1.9 OPERATIONS AND MAINTENANCE MANUALS

- A. Bind manuals in three-ring, high quality vinyl covered binders, clearly indexed and provided with thumb tabs for each item or product. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each. Index tabs shall match submittal schedule and include any additional information required for operations and maintenance, whether in submitted schedule or not.
- B. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.
- C. Provide copy of approved submittal for each product included in manual
- D. Provide printed copy and electronic configuration files for all packaged equipment control systems furnished with equipment.

- E. Mark the model actually provided where the literature covers more than one model. Include four copies of all submittal data corrected to "as-built" conditions within the manual.
- F. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.
- G. Manual Content: Manuals shall contain complete information for each item of mechanical electrical or other operating equipment. Include as applicable:
  - 1. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance
  - 2. Lubrication schedules
  - 3. Performance capacity
  - 4. Catalog data sheets
  - 5. Parts list
  - 6. Maintenance schedules

### 1.10 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Alternately, provide electronically using .pdf markup of contract drawings.

# PART 2 - PRODUCTS

# 2.1 PRODUCTS AND MATERIALS

- A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.
- B. Equipment used as the basis of design is scheduled on Drawings or designated in product specifications. If Contractor chooses to use equipment that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.

# 2.2 ROOF CURBS, BASES, AND RAILS

- A. Acceptable Manufacturer: Greenheck, The Pate Company, Thybar.
- B. Roof equipment curbs, bases and rails shall be provided by supplier of associated equipment and conform to the following requirements and to requirements shown on Drawings:
  - 1. General:

- a. Submittals: Provide curb, base, and rail submittals as part of associated rooftop equipment submittal packages.
- b. Seismic and Wind Load: Design curbs, bases, and rails to withstand seismic and wind load forces on equipment in accordance with performance requirements listed in Section 20 0548 "Vibration and Seismic Control for HVAC". Provide attachments including
  - 1) Equipment to curb, base, or rail.
  - 2) Curb, base, or rail to building structure.
- c. Provide design calculations verifying that seismic and wind load restraint will comply with the Oregon Structural Specialty Code for the site and the building type listed. Drawings, details, and calculations related to seismic and wind load design shall be signed and sealed by an engineer specializing in the associated work and registered in Oregon.
- 2. Coordination: Coordinate configuration and height of curb with roofing contractor.
  - a. Provide sloped curbs to match roof conditions.
  - b. Curbs shall be provided with cants compatible with roofing system and roofing insulation thickness in accordance with roofing manufacturer's recommendations.
  - c. Provide 14-inch curbs, except as shown on Drawings. Adjust curb height for roof insulation thickness. Exposed curb height above insulation shall be not less than twelve inches.
- 3. Equipment Bases:
  - a. Base: 16-inch tall constructed of G90 galvanized steel framing. Design internal framing to accommodate piping and conduit shown routed through curb housing. Components shall be non-combustible.
  - b. Platform: Structural deck and minimum 22-gauge 304 stainless steel cap flashing with welded corner seams. Deck shall support a minimum uniform top loading of 100 pounds per square foot, excluding equipment point loads.
  - c. Support Channels: Provide structural channel or hat channel welded to top of cap flashing for equipment support and anchorage. Support channel shall be designed to support equipment point loading and located for attachment to equipment base connections. Channel shall be sized to provide required horizontal bearing surface as required by equipment manufacturer and to accommodate vibration isolation.
  - d. Insulation: Factory or field applied closed-cell insulation with a minimum R-value of R-4.

### PART 3 - EXECUTION

# 3.1 ACCESS TO EQUIPMENT AND ACCESSORIES

A. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer's recommendations, provide larger clearance of the two.

- B. If equipment location shown on Drawings does not allow required access, notify Architect/ Engineer prior to start of work.
- C. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to Architect/Engineer for resolution prior to starting work.

#### 3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, lights, electrical outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- C. Minor Piping: Small diameter pipe runs from drips and drains, water cooling, and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor piping where needed to maintain mechanical spaces clean and dry and to allow full equipment function and maintenance.

### 3.3 CLEANING SYSTEMS

A. General: After all equipment, pipes and duct systems are installed, system shall be thoroughly cleaned. Remove all stickers and tags from equipment or fixtures. Clean all piping systems prior to installation of insulation or painting.

### 3.4 START UP

- A. The Mechanical Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.
- B. Start equipment in accordance with manufacturer's recommendations and under manufacturer's supervision where required. Ensure that associated filters, strainers, electrical overloads, and other devices intended to protect the equipment are installed and functional prior to startup.

### 3.5 TRAINING

A. Instruct Owner in proper operation and maintenance of equipment and systems. Instruction shall generally include topics listed in manufacturer's operations and maintenance manual. Operator instructions shall cover all aspects of manual, automatic, and safety controls. Contractor shall also instruct the Owner in the general configuration of systems and location of equipment and components.

### END OF SECTION 23 0500

# SECTION 23 0529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

#### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes hangers and supports for HVAC piping and equipment.

#### 1.2 DEFINITIONS

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

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Supports for multiple pipes, including pipe stands, shall be capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Equipment supports shall be capable of supporting combined operating weight of supported equipment and connected systems and components.

### 1.4 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 0500 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Detailed Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Pipe Hangers and Supports		Х						
Thermal Hanger Shield Inserts		Х						

# 1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

# PART 2 - PRODUCTS

#### 2.1 PIPE HANGERS AND SUPPORTS

- A. Copper-Coated Pipe Hangers:
  - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
  - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

#### 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
- 2.3 METAL FRAMING SYSTEMS
  - A. MFMA Manufacturer Metal Framing Systems:
    - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. B-line, an Eaton business
      - b. Thomas & Betts Corporation, a member of the ABB Group
      - c. Unistrut, part of Atkore International
    - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
    - 3. Standard: MFMA-4.
    - 4. Channels: Continuous slotted steel channel with in-turned lips.
    - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
    - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
    - 7. Metallic Coating: Pre-Galvanized Hot Dipped, ASTM A653, 0.75 MIL

### 2.4 INSULATION INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. National Pipe Hanger Corporation
  - 2. Pipe Shields Inc.
  - 3. Insulshield
  - 4. Uni-Grip
- B. General: Insulation insert for use with MSS Type 40 protection shield.
- C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

# 2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Cooper B-Line, Eaton, Mifab, Erico, or approved.
- C. Compact Pipe Stand:
  - 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
  - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
  - 3. Hardware: Galvanized steel or polycarbonate.
  - 4. Accessories: Protection pads.
- D. Low-Profile, Single-Base Pipe Stand:
  - 1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
  - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
  - 3. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channel.
  - 4. Pipe Supports: Strut clamps.
  - 5. Hardware: Galvanized steel.
  - 6. Accessories: Protection pads.
  - 7. Minimum Height: 6 inches above roof.

# 2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

- 1. Properties: Non-staining, noncorrosive, and nongaseous.
- 2. Design Mix: 5000-psi, 28-day compressive strength.

### PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Fastener System Installation:
  - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Roof Pipe Stand Installation: Mount on smooth roof surface. Do not penetrate roof membrane.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying. Coordinate with Section 23 0548 Vibration and Seismic Controls for interrelated work.
- J. Install building attachments within concrete slabs or to structural steel where possible. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes.
- M. Insulated Piping:
  - 1. Piping Operating Above Ambient Air Temperature:
    - a. Steel Piping 4-inches and Larger: Provide MSS Type 39 Protective Saddle.
    - b. All Other Piping 1-1/2-inches and larger: Provide Insulation Insert with MSS Type 40 protection shield.
    - c. All Piping 1-1/4-inches and smaller: Provide MSS Type 40 protection shield.
  - 2. Piping Operating Below Ambient Air Temperature:
    - a. All Piping 1-1/2-inches and Larger: Provide Insulation Insert with MSS Type 40 protection shield.
    - b. All Piping 1-1/4-inches and smaller: Provide MSS Type 40 protection shield.
  - 3. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
  - 4. Insulation Inserts: Same thickness as piping insulation.

# 3.2 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

# 3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.4 HANGER SPACING

#### A.

HYDRONIC PIPING SPACING TABLE	Maximum Horizontal Span	Maximum Vertical Spacing
Copper Tubing		
<sup>3</sup> / <sub>4</sub> inch and smaller	5 feet	10
1 inch to 2 inch	7 feet	10

### 3.5 ROD SIZES

A. Select rod diameter to not exceed the maximum safe load listed in Table 2 of MSS SP-58-2009.

### 3.6 HANGER AND SUPPORT TYPE SCHEDULE

- A. Single Pipe, Hung and Uninsulated
  - 1. NPS 1/2 to NPS 3: Adjustable Steel Band Hangar, MSS Type 7.
- B. Single Pipe, Hung and Insulated
  - 1. Operating Temperature Less Than Ambient: Steel Clevis, MSS Type 1
  - 2. Operating Temperature Greater Than Ambient.
    - a. NPS 1/2 to NPS2: Steel Clevis, MSS Type 1.
- C. Multiple Pipe Trapeze or Pipe Rack: Trapeze Hanger, MSS Type 59.
  - 1. Uninsulated Piping: Steel Strap.
  - 2. Insulated Piping: Adjustable Roller, MSS Type 43.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use copper-plated pipe hangers and attachments for copper piping and tubing.
- F. Use padded hangers for piping that is subject to scratching.
- G. To eliminate the need for seismic restraint, for piping installation where the distance from the top of the pipe to the structure is 12 inches or less for the entire run, select hanger-rod and building attachments to allow pipe movement without stress on hangers and attachments.
- H. Hanger-Rod Attachments: Unless otherwise indicated, provide the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
  - 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  - 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F piping installations.

- I. Building Attachments: Unless otherwise indicated, provide the following types:
  - 1. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  - 2. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  - 3. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications.
- L. Comply with MFMA-103 for metal framing system selections and applications.
- M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 0529

### SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Pipe labels.
  - 3. Valve tags.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

#### 1.3 COORDINATION

A. Coordinate with Division 22. Match manufacturer, type, and style of identification used.

### PART 2 - PRODUCTS

- 2.1 GENERAL
  - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1. Brady Corporation.
    - 2. Marking Services, Inc.
    - 3. Seton Identification Products.

### 2.2 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: 0.025-inch aluminum. Predrilled or stamped holes for attachment hardware.
  - 2. Letter Color: Black.

- 3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- 4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- 5. Fasteners: Stainless-steel rivets or self-tapping screws.
- 6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
  - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
  - 2. Engraved to show white lettering on black background except for labels attached to ceiling grid or located within finished spaces shall have black lettering on white background.
  - 3. Maximum Temperature: Able to withstand temperatures up to 160°F.
  - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering. Lettering on labels attached to ceiling grid largest size practical.
  - 6. Fasteners: Stainless-steel rivets or self-tapping screws.
  - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number.
- D. Equipment Label Schedule: For each item of equipment to be labeled, prepare equipment label schedule on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

### 2.4 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Brady Corporation.
  - 2. Marking Services Inc.
  - 3. Seton Identification Products.
- B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: Polished brass, 0.025-inch aluminum and having predrilled or stamped holes for attachment hardware.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

### PART 3 - EXECUTION

### 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment. Label ceilings or ceiling grid (not the tile) to indicate key access points for equipment, valves, and other components requiring quick access or routine maintenance. Provide a clear adhesive label and bold black lettering with equipment and valve identification information.

# 3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each flange.
  - 3. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 4. Near penetrations and on both sides of walls, floors, ceilings, and inaccessible enclosures.
  - 5. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 6. Near major equipment items and other points of origination and termination.
  - 7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule: Letter and background color in accordance with ANSI A13.1.

# 3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and isolation valves for HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves with captions as indicated in the following subparagraphs:
  - 1. Valve-Tag Information: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch valve tag numbers.

END OF SECTION 23 0553

# SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

- 1.1 SUMMARY
  - A. Section Includes:1. Testing, adjusting, and balancing existing systems and equipment.
- 1.2 DEFINITIONS
  - A. AABC: Associated Air Balance Council.
  - B. BAS: Building automation systems.
  - C. NEBB: National Environmental Balancing Bureau.
  - D. TAB Specialist: An independent entity meeting qualification to perform TAB work.
  - E. TAB Project Supervisor: Certified individual employed by balancing contractor having administrative and technical responsibility for work performed under this Section.
  - F. TAB: Testing, adjusting, and balancing.
- 1.3 INFORMATIONAL SUBMITTALS
  - A. Pre-construction TAB Reports:
    - 1. Existing Conditions TAB Report: Within 30 days of Contractor's Notice to Proceed, submit the as specified in Part 3 "Procedures for Testing, Adjusting, and Balancing Existing Systems."
  - B. TAB reports.
    - 1. Draft TAB Report
    - 2. Certified Final TAB report.

# 1.4 QUALITY ASSURANCE

- A. All work under this Section shall be performed under the direction of the Certified TAB Supervisor.
- B. TAB Specialists Qualifications: Certified by AABC or NEBB.
  - 1. TAB Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
  - 2. TAB Technician: Employee of the TAB specialist working under the supervision of the TAB Supervisor.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

### 1.5 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

### PART 2 - PRODUCTS (Not Applicable)

# PART 3 - EXECUTION

### 3.1 TAB SPECIALISTS

- A. Subject to compliance with requirements, engage one of the following:
  - 1. Air Balancing Specialties.
  - 2. Air Introduction and Regulation, Inc.
  - 3. Neudorfer Engineering, Inc.
  - 4. Southern Oregon Engineering Services, Inc.

# 3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
  - 1. Comply with requirements in ASHRAE 62.1, "Air Balancing."
- B. Cut insulation, ducts for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, install test ports and duct access doors as required in Section 23 3300 "Air Duct Accessories." Otherwise, patch probe holes in ducts with same material and thickness as used to construct ducts.
- C. Mark equipment and balancing devices, including damper-control positions with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

# 3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Determine the best locations in branch ducts for accurate duct-airflow measurements.
- C. Check dampers for proper position to achieve desired airflow path.

- D. Check for airflow blockages.
- E. Verify that air duct system is sealed as specified in Section 23 3113 "Metal Ductwork."
- F. Air Inlets and Outlets:
  - 1. Supply Diffusers: Set airflow patterns of adjustable outlets for proper distribution without drafts.

#### 3.4 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work. TAB shall be performed to achieve system performance shown on Drawings and as specified. TAB shall be performed for interrelated equipment and systems which are not otherwise modified, but where testing, adjusting, and balancing is required to achieve overall system performance and to maintain existing equipment and systems that are unmodified operating at preconstruction conditions.
  - 1. Verify each air outlet.
- B. Perform preconstruction inspection and measurement operating condition of existing equipment interconnected with new work and will remain and be reused. Preconstruction tests shall be performed within 30 days of the Contractors Notice to Proceed and prior to the beginning of any construction work and other activities that affect the performance of existing systems and equipment. If measurements are not performed as specified, comprehensive testing, adjusting, and balancing shall be performed for all interconnected systems and equipment.
  - 1. Measure and record the airflow of each air inlet & outlet.
  - 2. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- C. Prepare an Existing Conditions TAB Report documenting inspections and measurements.

### 3.5 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
  - 1. Air Outlets and Inlets: Plus or minus 10 percent.

# 3.6 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
  - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:

- 1. Field test reports prepared by system and equipment installers. Test reports shall be fully executed reports forms confirming to standard NEBB or AABC documentation standards.
- 2. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB specialist.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  - 14. Notes to explain why certain final data in the body of reports vary from indicated values.

END OF SECTION 23 0593

### SECTION 23 0713 - DUCT INSULATION

### PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes insulation of HVAC ductwork.

# 1.2 ACTION SUBMITTALS

- A. Provide submittals in accordance with Section 23 0500 General HVAC Provisions as follows:
  - 1. Provide catalog data for all products. Indicate thermal conductivity, water vapor permeance, and jackets (both factory and field applied) if any.

# 1.3 QUALITY ASSURANCE

- A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

### 1.4 COORDINATION

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

# 1.5 SCHEDULING

- A. If duct leak testing is required, schedule insulation application after systems are tested and, where required. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

# PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation
    - b. Johns Manville, a Berkshire Hathaway company
    - c. Knauf Insulation

#### 2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

#### 2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
  - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180°F.
  - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 4. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
  - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  - 2. Service Temperature Range: Minus 50 to plus 220°F.
  - 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

4. Color: White.

### 2.4 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250°F.
  - 4. Color: Aluminum.

# 2.5 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 6.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

# 2.6 SECUREMENTS

- A. Insulation Pins and Hangers:
  - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inchdiameter shank, length to suit depth of insulation indicated.
    - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  - 4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

- b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inchdiameter shank, length to suit depth of insulation indicated.
- c. Adhesive-backed base with a peel-off protective cover.
- 5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- 6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inchthick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

# PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.

- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### 3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (Not Fire Rated): Install insulation continuously through walls and partitions.

# 3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, and manufacturer's recommended percent coverage of duct and plenum surfaces.
  - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  - 3. Install support pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

- c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
- d. Do not over-compress insulation during installation.
- e. Impale insulation over pins and attach speed washers.
- f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
  - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vaporbarrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
- 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.6 INDOOR DUCT INSULATION SCHEDULE

- A. Insulate supply ductwork located indoors above ceiling in unconditioned space.
  - 1. Mineral-Fiber Blanket: 2 inches thick.

### END OF SECTION 23 0713
## SECTION 23 0719 - HVAC PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes jacking installation of pre-insulated piping above roof level

#### 1.2 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 0500 General HVAC Provisions.
  - 1. Catalog Data.
  - 2. For each type of product listed, provide thermal conductivity and water-vapor permeance.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

- A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.
- B. Surface-Burning Characteristics: Products shall have flame spread and smoke developed ratings based on test procedures in accordance with NFPA-255 and UL 723. Rating shall be indicated on the product or on the shipping containers.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

### 1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

# PART 2 - PRODUCTS

#### 2.1 ADHESIVES

- A. Materials compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- 2.2 MASTICS
  - A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

## 2.3 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. ITW Insulation Systems; Illinois Tool Works, Inc.
  - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
    - d. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
    - e. Factory-Fabricated Fitting Covers:
      - 1) Same material, finish, and thickness as jacket.
      - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      - 3) Tee covers.
      - 4) Flange and union covers.
      - 5) End caps.
      - 6) Beveled collars.
      - 7) Valve covers.
      - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

# 2.4 TAPES

- A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
  - 1. Width: 2 inches.
  - 2. Thickness: 3.7 mils.

- 3. Adhesion: 100 ounces force/inch in width.
- 4. Elongation: 5 percent.
- 5. Tensile Strength: 34 lbf/inch in width.

# PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- B. Keep insulation materials dry during application and finishing.
- C. Apply insulation and jacket manufacturer approved adhesives, mastics, and sealants at recommended coverage rate and wet and dry film thicknesses.
- D. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

# 3.3 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

### 3.4 FIELD-APPLIED JACKET INSTALLATION

A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.5 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Provide jacketing for all outdoor pre-insulated piping.
- B. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- C. If more than one material is listed, selection from materials listed is Contractor's option.
- D. Piping, Concealed:

- 1. None.
- E. Piping, Exposed:
  - 1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.032 inch thick.

## SECTION 23 0923 - BUILDING AUTOMATION SYSTEMS FOR HVAC

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Work hereunder includes providing a new space sensor and connecting to an existing Schneider controls through the building network for monitoring IT room space temperature. Associated work includes but is not limited to:
  - 1. New space temperature sensor, including installation, wiring and programming.
  - 2. Other materials and devices not shown as part of other work but necessary to provide mechanical system control and monitoring sequences specified.

### 1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Control Contractor to coordinate with other trades to ensure delivery and correct installation of products furnished but not installed under this section. Coordination to include a review of schedule, manufacturer's installation requirements, and equipment locations.

### 1.3 SUBMITTALS

- Provide submittals for products listed in the Product Table below in accordance with Section 23 0500 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products This Section	Х		Х					Х

- B. Special Requirements:
  - 1. Submittals prior to starting work:
    - a. Submit in accordance with Section 01 3300 SUBMITTAL PROCEDURES and Section 23 0500 GENERAL HVAC PROVISIONS.
    - b. Building Automation System Hardware.

#### 1.4 DESIGN REQUIREMENTS

A. BACnet Compliance

- 1. The BAS shall exchange data between workstations or workstations and building level controllers over the Management Level Network and First-tier BAS Controller Level Network using BACnet Protocol in the form of BACnet objects.
- 2. The BAS shall perform network functions using the following BACnet services:
  - a. Alarm and Event
  - b. Scheduling
  - c. Trending
  - d. Network Management

### 1.5 QUALITY ASSURANCE

- A. All products required to conform to BACnet Standards must be BACnet Testing Laboratory (BTL) listed.
- B. All products used in this application, except for those specifically indicated for reuse, shall be new and under current manufacture and shall be the most recent version offered by the manufacturer for the application. Spare parts shall be available from the manufacturer for at least five years after final completion.

### 1.6 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with all local, state, and federal codes and ordinances including but not limited to the following.
- B. Each DDCP shall be listed under UL916 (Energy Management Systems), UL864-UDTZ (Signal Systems Unit) and shall be tested to comply with sub-part J of Part 15 FCC rules for Class A computing equipment.
- 1.7 UPDATES
  - A. Provide at no extra cost all software and firmware updates that become available from the manufacturer during the warranty period.

### PART 2 – PRODUCTS

- 2.1 ACCEPTABLE MANUFACTURERS
  - A. Andover, engineered and installed by Robert Lloyd Sheet Metal.
- 2.2 WORKSTATION GRAPHICS
  - A. System Graphics: Update existing graphics with new floor plan and monitored system within the project scope.
- 2.3 SYSTEM CONTROLLERS
  - A. Utilize existing controller for new point on BAS.

#### 2.4 WIRING AND RACEWAYS

- A. Provide wiring, plenum cable, and raceways in accordance with Division 26.
- B. All insulated wire to have copper conductor. UL labeled for 90 degree C service.

#### 2.5 TEMPERATURE MEASUREMENT

- A. Temperature Sensors
  - 1. Acceptable Manufacturers: Veris or approved Direct Digital Control System manufacturer.
  - 2. DDC space air temperature sensor: wall mounted with vandal-resistant heavy plastic housing. or stainless-steel cover.
  - 3. Sensing element:
    - a. Thermistor type,  $\pm -0.5^{\circ}$ F from 40°F to 90°F accuracy, less than 0.25°F drift/year.
    - b. Compatible with BMCS analog input requirements.
    - c. Select sensor with smallest range available that will span anticipated sensed medium temperature range.

#### PART 3 – EXECUTION

### 3.1 COORDINATION

A. Coordinate with controls specified in other sections or divisions. Other sections or divisions include controls and control devices to be part of or interfaced with the control system specified in this section. Integration and coordination with these controls shall be as follows.

#### 3.2 WORKMANSHIP

- A. Install all equipment in accordance with manufacturers' recommendations.
- B. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
- C. Provide sufficient slack and flexible connections in wiring to allow for vibration of piping and equipment.
- D. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electric Code.

#### 3.3 EXISTING EQUIPMENT

- A. Local Control Panels: Utilize nearest available input on existing system for installation.
- B. Unless specifically stated elsewhere, Contractor is not responsible for the repair or replacement of existing control system equipment to be reused. Such equipment includes but is not limited to control devices, valves, dampers, or actuators. Should the Contractor find existing equipment requiring maintenance, Contractor shall notify the Owner immediately. Repair will be performed under separate Contract.

### 3.4 IDENTIFICATION OF HARDWARE AND WIRING

- A. Label all wiring and cabling, including wiring and cabling terminating within factory-fabricated panels, within 2 inches of termination with the BAS address or termination number.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum <sup>1</sup>/<sub>2</sub>-inch letters on laminated plastic nameplate.
- D. Identify all other control components with permanent labels. All plug-in components shall be labeled so that removal of component does not remove label.
- E. Identify room sensors relating to terminal box or valves with nameplate located within sensor cover.
- F. Arrange components so that UL or CSA labels are visible after equipment is installed.
- G. Identifiers shall match record documents.
- H. Provide laminated network communication diagrams, point-to-point wiring diagrams, and process control diagrams in each control panel for control components contained therein.

#### 3.5 PROGRAMMING

A. Provide programming for the system as required.

#### 3.6 GRAPHICS

- A. Update graphics for all controlled systems within the project scope.
- 3.7 CONTROL SYSTEM CHECKOUT AND TESTING
  - A. Contractor shall completely test and verify specified control system performance. Compile test results and include with written certification.
  - B. Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all instruments, controls, and accessory equipment furnished hereunder.

#### 3.8 DEMONSTRATION AND ACCEPTANCE

- A. Demonstrate operation of control system to Owner and Engineer including:
  - 1. Menu functions
  - 2. Point overrides
  - 3. Control loop response after point modification
  - 4. Alarm response time

## 3.9 TRAINING

A. Provide a minimum of 2 hours training to Owner's personnel in use and maintenance of new equipment and systems installed.

# 3.10 SENSORS AND TRANSMITTERS

- A. Space Temperature Sensors:
  - 1. Mount on wall or on ceiling pendant as shown on Drawings. Provide concealed junction boxes properly supported by wall or ceiling framing.
  - 2. Wall mounting heights, above finished floor:
    - a. Sensors with displays and/or user inputs: 48 inches.
    - b. Sensors without displays or user inputs: 60 inches
  - 3. All wires attached to sensors shall be air sealed in their raceways to prevent air transmitted from other areas from affected sensor accuracy.

# 3.11 SPLIT SYSTEM SEQUENCE OF OPERATIONS (FC-1 & CU-1)

- A. General: Constant volume recirculating two-pipe fan coil unit on direct expansion system. System operation is stand-alone to BAS. BAS to monitor IDF room space temperature.
- B. Space Temperature Monitoring: Monitor IDF room space temperature with wall sensor. Space cooling temperature setpoint will be maintained by packaged controls thermostat.
- C. Safety Control:
  - 1. High Temperature: Initiate a critical BAS workstation alarm if the IDF room temperature exceeds 90°F. Maintain alarm until acknowledged by operator.
- D. Input/Output Points List
  - 1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points listed below. Where BAS points are obtained from packaged equipment, the equipment connection is listed following the point description.

BAS Points List	<b>Equipment Connection</b>
Analog Inputs	
Machine room space temperature	

# SECTION 23 2113 - ABOVE GROUND HYDRONIC PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes pipe, fittings, and joining methods for HVAC systems.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. All hydronic piping, equipment, fittings, and accessories shall be capable of withstanding the following maximum pressure and temperature. Exceptions would include specific items of equipment where a lower operating pressure is specified.
  - 1. Condensate-Drain Piping:
    - a. Maximum operating pressure: 50 psig.
    - b. Maximum operating temperature: 7°F.

#### 1.3 ACTION SUBMITTALS

- A. Provide materials list for pipe and fittings.
- B. Provide catalog data for dielectric fittings.
- 1.4 QUALITY ASSURANCE
  - A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
  - B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
    - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
    - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
  - C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

### PART 2 - PRODUCTS

- 2.1 COPPER TUBE AND FITTINGS
  - A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
  - B. Drawn-Temper Copper Tubing: ASTM B 88, Type M.

- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- 2.2 JOINING MATERIALS
  - A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
  - B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

### PART 3 - EXECUTION

#### 3.1 PIPING APPLICATIONS

- A. Condensate-Drain Piping:
  - 1. 1-1/4 and larger: Type DWV drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
  - 2. 1-inch and smaller: Type M copper.

#### 3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved by Engineer.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

- K. Install drains and cleanouts, consisting of a tee fitting and short NPS <sup>3</sup>/<sub>4</sub>-threaded nipple with cap, as required for complete condensate system drainage and cleaning.
- L. Install piping at a uniform grade of 0.2 percent downward in direction of flow.
- M. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- N. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- 3.3 HANGERS AND SUPPORTS
  - A. Comply with requirements in Section 23 0529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices.
  - B. Support vertical runs at roof and at each floor.
- 3.4 PIPE JOINT CONSTRUCTION
  - A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  - B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  - C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

## SECTION 23 2313 - REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Field installed refrigerant piping for HVAC system.
- B. Provide all materials, labor, equipment and services necessary for a complete and operable refrigeration piping systems including all refrigerant tubing, valves, specialties, fittings, refrigerant, and other installation material, together with all labor and permits required to completely install and perform the services shown on Drawings and described herein.

## 1.2 ACTION SUBMITTALS

- Provide submittals for products listed in the Product Table below in accordance with Section 23 0500 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Refrigerant Piping	Х							

#### PART 2 - PRODUCTS

#### 2.1 REFRIGERANT PIPING

- A. Pre-insulated, flexible soft copper:
  - 1. Pipe: ASTM C 534. Piping shall be refrigeration grade, cleaned, sealed and capped. Sizes up to 1-1/8".
  - 2. Joints: No joints between equipment connections.
  - 3. Insulation: Closed cell elastomeric foam: 3/4" thickness.

# 2.2 VALVES

A. Ball Valve: Forged brass body, Teflon seats, quarter turn valve stem. Extended copper brazing connections. Maximum working pressure 700 psig. Maximum working temperature 250°F. Similar to Henry Valve Co. Type 937.

# PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Piping shall be installed in workmanlike manner in conformance with provisions and intent of Specifications and Drawings. Changes in direction made by appropriate use of fittings.
- B. Care shall be taken to keep the entire system clean and dry during installation. Nitrogen gas shall flow through the piping being welded to prevent scaling during the welding operation. Owner has option to cut maximum of two welded fittings to inspect proper use of nitrogen. Refrigeration contractor shall replace all fittings as directed if oxidation is present at any one of the fittings inspected.
- C. The liquid and suction refrigeration lines from the compressor to fixture shall be of the size designated and run generally as shown on Drawings or as recommended by the equipment manufacturer.
- D. Hot gas piping shall be sloped 1/2-inch per every 10 feet from compressors to condenser.
- E. Provide oil traps in hot gas piping adjacent to compressor, inverted traps at entering and leaving condenser connections, and isolation valves as recommended by equipment manufacturer and as required for proper operation.
- F. All piping shall be installed to allow for expansion and contraction without harm to system.
- G. Piping shall be arranged so that normal inspection and servicing of the compressors is not hindered. Do not obstruct the view of the sight glasses or run piping so it interferes with removal of the compressor or other parts.
- H. Soft Copper Tubing:
  - 1. Bend in accordance with manufacturer recommendations to prevent kinks.
  - 2. Support piping without sags.
  - 3. Cut piping to required lengths.

# 3.2 LEAK TESTING

- A. Contractor shall notify Engineer prior to leak test. Contractor shall obtain all permits and inspections required by governing authorities.
- B. After piping connections have been completed, raise system pressure to 150 psi, or higher pressure if required governing authority, with all other valves open. Pressure test to be accomplished by first charging enough refrigerant into the port in the liquid shut-off valve on the receiver to raise the pressure in the system to 10 to 20 psi. Then enough dry nitrogen shall be introduced to raise the pressure to the required test pressure. A suitable pressure regulating valve shall be attached to the nitrogen cylinder to reduce pressure of the testing gas to test pressure. All joints shall then be carefully tested for leaks, using a Halide torch or an electronic Halogen Leak Detector.
- C. All tests shall be logged as to date and time and pressure at start and end of test. Owner's Authorized Representative shall witness and approve tests.

## 3.3 SYSTEM CHARGING

- A. Charge system using the following procedures:
  - 1. Install core in filter dryers after leak test but before evacuation.
  - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
  - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
  - 4. Charge system with a new filter-dryer core in charging line.

# 3.4 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Open shutoff valves in condenser water circuit.
  - 2. Verify that compressor oil level is correct.
  - 3. Open compressor suction and discharge valves.
  - 4. Open refrigerant valves except bypass valves that are used for other purposes.
  - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

## SECTION 23 3113 - METAL DUCTWORK

#### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes metal ductwork, liner, and related fittings and sealants.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards Metal and Flexible"
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- 1.3 ACTION SUBMITTALS
  - A. See Section 23 0500 for general submittal requirements.
  - B. Materials List:
    - 1. Shop fabricated ductwork:
  - C. Catalog Data:
    - 1. Pre-manufactured Ductwork and Fittings.
  - D. Shop Drawings:
- 1.4 INFORMATIONAL SUBMITTALS
  - A. Field quality-control reports.
- 1.5 QUALITY ASSURANCE
  - A. Welding Qualifications: Qualify procedures and personnel according to the following:
    - 1. AWS D1.1/D1.1M, "Structural Welding Code Steel," for hangers and supports.
    - 2. AWS D1.2/D1.2M, "Structural Welding Code Aluminum," for aluminum supports.
    - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
  - B. Comply with applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and System Start-up."

C. Comply with applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

# PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Sealing Requirements:
  - 1. Concealed: Seal longitudinal seams and transverse joints with liquid duct sealer or tapeand-adhesive. Flanged, gasketed joints that meet seal requirements do not require separate duct sealant application.
  - 2. Exposed: Seal non-flanged transverse joints with liquid duct sealer, specified herein, applied to male end fittings only, so that sealer is not visible when joint is assembled.

# 2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. General: Round ductwork may be either shop or factory fabricated. Flat-oval ductwork shall be factory fabricated.
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering factory fabricated products that may be incorporated into the Work include, but are not limited to the following:

- 1. McGill AirFlow LLC.
- 2. MKT Metal Manufacturing.
- 3. Sheet Metal Connectors, Inc.
- 4. Spiral Manufacturing Co., Inc.
- D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
  - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
  - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with buttwelded longitudinal seams.
- F. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
- G. Sealing Requirements:
  - 1. Concealed: Flanged, gasketed joints that meet seal requirements do not require separate duct sealant application.
  - 2. Exposed: Seal non-flanged transverse joints with liquid duct sealer, specified herein, applied to male end fittings only, so that sealer is not visible when joint is assembled.

## 2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.4 SEALANT AND GASKETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries
  - 2. McGill AirSeal LLC.
  - 3. Carlisle HVAC Products
- B. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- C. Water-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Solids Content: Minimum 65 percent.
  - 3. Shore A Hardness: Minimum 20.
  - 4. Water resistant.
  - 5. Mold and mildew resistant.
  - 6. VOC: Maximum 75 g/L (less water).
  - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  - 8. Service: Indoor or outdoor.
  - 9. Substrate: Compatible with galvanized sheet steel.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
  - 1. General: Single-component, acid-curing, silicone, elastomeric.
  - 2. Type: S.
  - 3. Grade: NS.
  - 4. Class: 25.
  - 5. Use: O.
  - 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

### 2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

# PART 3 - EXECUTION

- 3.1 DUCT INSTALLATION
  - A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved by Engineer.
  - B. Install ducts according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible" unless otherwise indicated.
  - C. Install round and flat-oval ducts in maximum practical lengths.
  - D. Install ducts with fewest possible joints.
  - E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
  - F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
  - G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
  - H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
  - I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 3300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

# 3.2 DUCT SEALING

- A. Provide Seal Class in accordance with SMACNA's "HVAC Duct Construction Standards Metal and Flexible,"
- B. Clean duct surfaces prior to applying sealant.
- C. Prior to application, verify that ducts are dry and within specified temperature limits.
- D. Open ends of completed and overnight work-in-progress shall be sealed.
- 3.3 HANGER AND SUPPORT INSTALLATION
  - A. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 5, "Hangers and Supports."
  - B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
  - C. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
  - D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

# 3.4 CONNECTIONS

- A. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
- 3.5 FIELD QUALITY CONTROL
  - A. Perform tests and inspections.
  - B. Leakage Tests:

- 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
- 2. Test representative duct sections selected by Owner's Authorize Representative from sections installed.
- 3. Test the following systems:
  - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
- 4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- 5. Test for leaks before applying external insulation.
- 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
- 7. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
  - 1. Visually inspect duct system to ensure that no visible contaminants are present.
  - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

### 3.6 START UP

A. Air Balance: Comply with requirements in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC."

## 3.7 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.
- B. Seal Class
  - 1. Seal Class depending on Pressure Class in accordance with SMACNA's "HVAC Duct Construction Standards Metal and Flexible except as otherwise indicated.
- C. Leakage Class
  - 1. Leakage Class as required to meet recommended maximum leakage percentages as tabulated in ASHRAE Handbook "HVAC Systems and Equipment -2012, Chapter 19, Table 2
- D. All ductwork single wall, except as otherwise indicated.

- E. Supply Ducts:
  - 1. Ducts Connected to Constant-Volume Air-Handling Units:
    - a. Single wall
    - b. Pressure Class: Positive 4-inch w.g
  - 2. Ducts Connected to Terminal Units:
    - a. Pressure Class: Positive 2-inch w.g.
- F. Return Ducts:
  - 1. Ducts Connected to Air-Handling Units, Indoors:
    - a. Single wall.
  - 2. Pressure Class: Positive or negative 3-inch w.g.
- G. Intermediate Reinforcement: Match duct material.
- H. Elbow Configuration:
  - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - a. Velocity 800 fpm or Lower:
      - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      - 2) Mitered Type RE 4 without vanes.
    - b. Velocity 800 to 1500 fpm:
      - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-4, "Round Duct Elbows."
    - Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.

- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

# I. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Figure 4-6, "Branch Connection."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch:
    - 1) Velocity less 1000 fpm: Conical tap or 45-degree entry.
- 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity less 1000 fpm: Conical tap or 45-degree lateral.

### SECTION 23 3300 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes: Accessories for duct systems.

#### 1.2 ACTION SUBMITTALS

- Provide submittals for products listed in the Product Table below in accordance with Section 23 0500 General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Manual Volume Dampers		Х						
Turning Vanes		Х						

#### 1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

#### PART 2 - PRODUCTS

#### 2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

#### 2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

- 1. Galvanized Coating Designation: G60.
- 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.3 MANUAL VOLUME DAMPERS

- A. Acceptable Manufacturers
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Greenheck
    - b. Nailor Industries Inc.
    - c. Pottorff.
    - d. Ruskin Company.
    - e. Trox USA Inc.
    - f. Young Regulator Company.
- B. Round/Oval Single Blade Manual Volume Dampers:
  - 1. Operating Conditions:
    - a. Maximum temperature: 180°F
    - b. Maximum differential pressure: 1-inch water column.
    - c. Maximum air velocity: 2,000 fpm.
    - d. Standard leakage rating.
  - 2. Suitable for horizontal or vertical applications.
  - 3. Frames:
    - a. One piece 20-gauge construction. Material to match connected ductwork.
  - 4. Blades:
    - a. Single blade.
    - b. 20-gauge construction. Material to match connected ductwork.
    - c. Stiffen damper blades for stability.
  - 5. Blade Axles: Minimum 3/8-inch dia. plated steel.
  - 6. Bearings:
    - a. Oil-impregnated bronze.
    - b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.

- 7. Actuator:
  - a. Manual quadrant.
  - b. Elevated platform for insulated duct mounting.
- C. Single Blade Rectangular Manual Volume Dampers:
  - 1. Operating Conditions:
    - a. Maximum temperature: 180°F
    - b. Maximum differential pressure: 1-inch water column.
    - c. Maximum air velocity: 2,000 fpm.
    - d. Standard leakage rating.
  - 2. Suitable for horizontal or vertical applications.
  - 3. Frames: Hat-shaped, welded or gusset reinforced corners. 18-gauge construction. Material to match connected ductwork.
  - 4. Blades:
    - a. Single blade.
    - b. 20-gauge construction. Material to match connected ductwork.
    - c. Stiffen damper blades for stability.
  - 5. Blade Axles: Minimum <sup>1</sup>/<sub>2</sub> inch dia. plated steel or stainless steel.
  - 6. Linkages: Concealed in jamb outside or air stream.
  - 7. Bearings:
    - a. Oil-impregnated bronze.
    - b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
  - 8. Actuator:
    - a. Manual quadrant.
    - b. Elevated platform for insulated duct mounting.

### 2.4 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. Elgen Manufacturing.
  - 4. SEMCO LLC.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- C. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

- 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- D. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- E. Vane Construction: Single wall for ducts up to 18 inches wide and double wall for larger dimensions.

# 2.5 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

# PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install products in locations that are accessible and that will permit adjustment and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- C. Manual Volume Dampers:
  - 1. Install in ductwork where shown on drawings and as required to properly balance airflow rates to values shown on Drawings. Provide damper for each air inlet and outlet.
  - 2. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 3. Dampers must be accessible to allow inspection, adjustment, and replacement of components.
  - 4. Do not compress or stretch the damper frame into the duct or opening. Damper shall move freely throughout full range of travel.
  - 5. Dampers shall be rigid and secure not producing any audible noise due to vibration of components.
  - 6. Set dampers to fully open position before testing, adjusting, and balancing.
- D. Turning Vanes
  - 1. Install in mitered ductwork elbows and as shown on drawings.
  - 2. Install with leading and trailing edges parallel to entering and leaving airflow.
- E. Test Holes

1. Install test holes at fan inlets and outlets, coil inlets and outlets, and elsewhere as indicated.

## 3.2 APPLICATION

- A. Manual Volume Dampers:
  - 1. Material: Volume damper construction frame and blade material shall match material of connected ductwork.
  - 2. Type:
    - a. Round/Oval Single Blade Manual Volume Dampers: All round ductwork 20-inch diameter and below.
    - b. Round Multiple Blade Manual Volume Dampers: All round ductwork greater than 20-inch diameter in exposed or concealed locations.
    - c. Rectangular Single Blade Manual Volume Dampers: Rectangular ductwork where largest cross-sectional dimension is 18-inches and below.
    - d. Rectangular Multiple Blade Manual Volume Dampers:
      - 1) Round or oval ductwork greater than 20-inch diameter located in concealed locations. Provide rectangular to round transition for connecting to round ductwork.
      - 2) Rectangular or oval ductwork where largest cross-sectional dimension greater than 18-inches. Provide rectangular to oval transition for connecting to oval ductwork.

## 3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Operate dampers to verify full range of movement.
  - 2. Inspect turning vanes for proper and secure installation.

## SECTION 23 3713 - AIR OUTLETS AND INLETS

### PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Diffusers
  - 2. Grilles

# 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.

# 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Ceiling suspension assembly members.
  - 2. Size and location of initial access modules for acoustical tile.
  - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
  - 4. Duct access panels.

### PART 2 - PRODUCTS

### 2.1 COMMON REQUIREMENTS

- A. Source Quality Control
  - 1. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, unless specifically stated otherwise:
  - 1. Anemostat Products; a Mestek company.
  - 2. Krueger.
  - 3. Nailor Industries Inc.
  - 4. Price Industries.
  - 5. Titus.

### 2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS

- A. Square and Rectangular Neck Louvered Diffusers SD-1
  - 1. Basis of Design: Titus TDC
  - 2. Material: Steel.
  - 3. Finish: Baked enamel, white.
  - 4. Duct Inlet: Square or rectangular, size as shown on Drawings.
  - 5. Pattern: Four-way core style, or as shown on drawings.
  - 6. Mounting:
    - a. Surface: Beveled drop face, Titus Type 6
    - b. Suspended Ceiling: Flush, border type and module size compatible with ceiling system.
    - c. Exposed: Flush, Titus Type 1

### 2.3 RETURN/TRANSFER GRILLES

- A. Fixed Blade Grille RG/EG-1/TG-1
  - 1. Basis of Design: Titus 350 RL/RS
  - 2. Material: Steel.
  - 3. Finish: Baked enamel, white.
  - 4. Blade Arrangement: 35-degree blade deflection. Spaced 3/4 inch apart. Blades parallel to long dimension if installed in ceiling or horizontal position. Blades parallel to floor if installed in wall or vertical position.
  - 5. Frame: 1-1/4 inches wide.
  - 6. Mounting:
    - a. Surface: Countersunk screw.
    - b. Suspended Ceiling: Flush, border type and module size compatible with ceiling system.
    - c. Exposed: Countersunk screw.

#### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install diffusers level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final

locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Mounted devices tight to finished surface.

#### 3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

# SECTION 23 8128 - SPLIT SYSTEM AIR CONDITIONERS

#### PART 1 - GENERAL

- 1.1 SECTION INCLUDES
  - A. Indoor fan coil units
  - B. Air cooled outdoor units
- 1.2 ACTION SUBMITTALS
  - Provide submittals for products listed in the Product Table below in accordance with Section 23 0500 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
    - 1. Materials List
    - 2. Catalog Data
    - 3. Product Data
    - 4. Performance Data
    - 5. Wiring Diagrams
    - 6. Shop Drawings
    - 7. Installation Instructions
    - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products in this Section			Х	Х				

#### 1.3 QUALITY ASSURANCE

A. Units rated and certified in accordance with AHRI Standards 210/240 and 270.

#### PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
  - A. Daikin, Mitsubishi, LG, Fujitsu, or approved.
- 2.2 INDOOR SECTION, FC-1
  - A. General: Packaged indoor unit consisting of refrigerant coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing elements. UL listed. Configuration as indicated on Drawings. Furnished with integral mounting hardware.
  - B. Housing: High impact polystyrene discharge and inlet grilles. Fully insulated cabinet for thermal and noise control.
  - C. Supply Fan: Direct-drive forward curved fan wheel

- D. Refrigerant Coil: Aluminum fins mechanically bonded to seamless copper tubes. Galvanized steel tube sheets. Provided with condensate drain pan with internal trap and auxiliary drip pan under coil header.
- E. Motors: Motors open drip-proof, permanently lubricated ball bearing with inherent overload protection. 3-speed.
- F. Controls:
  - 1. Automatic restart after power failure with same operating conditions as at failure.
  - 2. Minimum 24-hour timer cycle for system Auto/start/stop. Auto stop feature to have integral setback control.
  - 3. Temperature-sensing controls shall sense return air temperature. Provide Indoor-air high temperature shut-down.
  - 4. Provide indoor coil freeze protection.
  - 5. Provide wireless infrared remote controller to enter setpoints and control operation.
  - 6. Provide fan-only operation to provide room circulation during occupied hours when no cooling is required.
  - 7. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages displayed at the unit and at the remote controller.
  - 8. Fan speed control user selectable.
  - 9. Provide three-minute compressor restart time delay.
- G. Filters: Filter track with factory supplied cleanable filters.
- H. Electrical Requirements: Power and control connections at unit terminal block.
- I. Accessories: Condensate pump consisting of two parts; an internal reservoir sensor assembly, and a remote sound-shielded pump assembly. 3 to 25 feet of vertical lift capacity. Equipped with condensate level high limit switch to stop cooling operation. Similar to Aspen pumps ASP-ML115 or ASP-ML0115.
- J. Capacity: Performance as scheduled on Drawings.

# 2.3 OUTDOOR SECTION, CU-1

- A. General: Outdoor-mounted, air-cooled split-system outdoor unit section suitable for on-theground, rooftop, wall hung, balcony, or under-deck installation. Unit shall include a hermetic reciprocating, scroll, or rotary compressor, an air-cooled coil, propeller-type blow-thru outdoor fans, reversing valve (heat pump only), accumulator, R-410a refrigerant charge, heating mode metering device, and control box. Horizontal discharge. UL listed. Each compressor circuit shall include a service valve set for connection of 2 indoor fan coil units.
- B. Sizing: Units used in a refrigeration circuit matched to a cooling fan coil(s).
- C. Cabinet: Galvanized steel, bonderized and coated with a baked-enamel finish.
- D. Compressor:
  - 1. Hermetic reciprocating or scroll type

- 2. Equipped with oil system, operating oil charge, and motor. Internal overloads to protect against over temperature and overcurrent.
- 3. Motors: NEA rated class F, suitable for refrigerant atmosphere
- 4. Mounted on rubber vibration isolators and equipped with internal spring isolators.
- E. Refrigerant Coil: Internally enhanced, seamless copper tubes mechanically bonded to aluminum fins. Cleaned, dehydrated, and sealed for shipment.
- F. Refrigeration Components: Brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schraeder type fittings, accumulator, filter drier, and pressure relief valve.
- G. Controls and Safeties: Operating controls and safeties factory selected, assembled, and tested. Control and safety functions shall include:
  - 1. Control:
    - a. Time delay restart to prevent compressor reverse rotation
    - b. Automatic restart on power failure
    - c. Safety lockout if any outdoor unit safety is open
    - d. High-pressure and liquid line low pressure switches
    - e. Automatic outdoor-fan motor protection
  - 2. Safeties:
    - a. System diagnostics
    - b. Compressor motor current and temperature overload protection
    - c. High pressure relief
    - d. Outdoor fan failure protection
- H. Accessories
  - 1. Winter Start Control Kit: Field installed winter start control to allow operation under low load and low outside temperature conditions by bypassing the low-pressure switch for a 3-minute delay period.
  - 2. Crankcase Heater: Clamp-on, field-installed, crankcase heater to allow operation when outside temperature is less than 40°F.
- I. Capacity: Performance as shown on Drawings.

#### 2.4 REFRIGERANT PIPING

- A. Provided hereunder. See section 23 2313 Refrigerant Piping.
- 2.5 WIRING AND RACEWAYS
  - A. Provide wiring, plenum cable, and raceways in accordance with NEC.
  - B. All insulated wire to have copper conductor. UL labeled for 90° C service.

# PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install as recommended by manufacturer and as shown on Drawings.
- B. Adjust refrigerant charge to optimize system operation.
- C. General Wiring
  - 1. All control and interlock wiring shall comply with national and electrical codes and Division 26. Where requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
  - 2. All low-voltage wiring shall meet NEC Class 2 requirements. Low voltage power circuits shall be sub-fused when required to meet Class 2 limits.
  - 3. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling plenum return air plenums, approved cable not in raceway may be used provided cables are UL listed for the intended application.
  - 4. All wiring in mechanical, electrical, or service rooms, wiring located where it may be subject to damage, and wiring exposed in finished spaces shall be installed in raceway.
  - 5. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring may not be used for low-voltage wiring except for the purpose of interfacing the two.
  - 6. Where Class 2 wiring is installed exposed, wiring is to be routed parallel or perpendicular to building lines and neatly tied at a maximum of 10-foot intervals.
  - 7. Where plenum cables are used without raceway, support or anchor cable from building structure. Do not anchor or support cable from ductwork, electrical raceways, piping, or suspended ceiling systems.
  - 8. Provide all wire-to-device connections at terminal block or terminal strip. Provide all wire-to-wire connections at terminal block.
  - 9. Neatly bundle wiring located within enclosures to permit access to devices and terminals.
  - 10. All wiring shall be installed as continuous lengths with no splices permitted between termination points.
  - 11. Provide size of raceway and size and type of wire as required by NEC and as required to meet manufacturers' recommendations for connected equipment.
  - 12. Use color coded conductors throughout.
  - 13. Conceal all raceways except within mechanical, electrical, or service rooms. Maintain minimum raceway clearance of 6-inches from high temperature equipment such as steam piping or boiler flues.
  - 14. Secure raceways with raceway clamps fastened to the structure and spaced in accordance with code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be supported from ductwork, electrical raceways, piping, or suspended ceiling systems.
  - 15. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all raceways.
  - 16. Maintain updated wiring diagrams (as-built) at site with terminations identified.
  - 17. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3-feet in length and shall be supported at both ends. Flexible metal raceway less than ½-inch electrical trade size shall not be used. In areas exposed to moisture, including but not limited to chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
## D. Communication Wiring

- 1. Install in accordance with "General Wiring" above.
- 2. Follow manufacturers' recommendations for all communications cabling including but not limited to maximum pulling, tension, and bend radius.
- 3. Do not install communications cabling in a raceway or enclosure containing Class 1 or other Class 2 wiring.
- 4. Verify the integrity of the entire network immediately following cable installation using test measures appropriate for each cable.
- 5. All communications wiring shall be un-spliced length when that length is commercially available.
- 6. All communications wiring shall be labeled to indicate origination and destination.
- 7. Ground coaxial cable in accordance with NEC regulations article on "Communications Circuits, Cable and Protector Grounding."
- 8. Controllers/Thermostats
  - a. Install where shown on Drawings, in accordance with "General Wiring" above.

# 3.2 ADJUSTMENT

- A. After installation is complete, check installation and start-up in accordance with manufacturer's instructions.
- B. Make necessary adjustments and cycle control to verify system performance.
- C. Program thermostat to schedule of operation and temperature settings provided by Owner.

END OF SECTION 23 8128

## SECTION 26 0500 - GENERAL ELECTRICAL PROVISIONS

#### PART 1 - GENERAL

#### 1.1 CONTRACT DOCUMENTS

- A. General electrical provisions apply to all work performed in Division 26, 27 & 28.
- B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.
- C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.
- D. Particular attention is called to Instructions to Bidders, General Conditions, Drawings and Specifications, and modifications incorporated in the documents before execution of the Agreement.
- E. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Architect/Engineer and Owner's Authorized Representative prior to fabrication.
- F. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.
- G. Use of the word "Provide" shall be equivalent to "Furnish and Install."

#### 1.2 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): The governmental agency or sub-agency which regulates the construction process.
- B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

#### 1.3 COORDINATION

- A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and secure written approval and agreement on necessary adjustments before start of work.
- B. Architectural drawings govern all other drawings. Consult in detail the door swings, counter heights and similar items affecting work before rough-in.
- C. Coordinate identification systems with other trades. All electrical systems shall use identical wiring, conduit, and equipment identification and regulatory signage.

## 1.4 SUBMITTALS AND SHOP DRAWINGS

- A. See Section 01 3300 "Submittal Procedures."
- B. Action Submittal Content
  - 1. Action submittal information not expressly required by the specifications will not be reviewed.
  - 2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
  - 3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
  - 4. Action submittal requirements are listed in individual specification sections. The following definitions apply.
    - a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
    - b. Catalog data: Manufacturer's standard product cut sheet.
    - c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.
    - d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
    - e. Wiring Diagrams: Power and control wiring diagrams.
    - f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
    - g. Installation Instructions
    - h. Special Requirements Listed: Additional requirements indicated in individual specification sections.
- C. Delegated Design
  - 1. Delegated work will include but is not limited to the following:
    - a. Section 26 0548 "Seismic Control for Electrical Systems."
    - b. Section 28 3100 "Fire Alarm."
  - 2. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

## 1.5 QUALITY ASSURANCE

- A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.
- B. Asbestos products or equipment or materials containing asbestos shall not be used.
- C. Certify that each welder has passed the American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

# 1.6 DESIGN REQUIREMENTS

- A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.
- B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

# 1.7 CODES AND STANDARDS

- A. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.
- B. Work shall comply with the Americans with Disabilities Act (ADA).

## 1.8 TEMPORARY SERVICES

- A. Provide in accordance with Section 01 5000 "Temporary Facilities and Controls" as required for completion of work. Provide additional filters as required to keep areas clean during construction.
- B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

## 1.9 OPERATIONS AND MAINTENANCE MANUALS

- A. Bind manuals in three-ring, high quality vinyl covered binders, clearly indexed and provided with thumb tabs for each item or product. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each. Index tabs shall match submittal schedule and include any additional information required for operations and maintenance, whether in submitted schedule or not.
- B. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.

- C. Provide copy of approved submittal for each product included in manual
- D. Provide printed copy and electronic configuration files for all packaged equipment control systems furnished with equipment.
- E. Mark the model actually provided where the literature covers more than one model. Include four copies of all submittal data corrected to "as-built" conditions within the manual.
- F. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.
- G. Manual Content: Manuals shall contain complete information for each item of mechanical, electrical or other operating equipment. Include as applicable:
  - 1. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance
  - 2. Performance capacity
  - 3. Catalog data sheets
  - 4. Parts list
  - 5. Maintenance schedules

#### 1.10 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from contract drawings and location of all underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. All concealed raceways, that contain feeder cables, communication conduits that are 1.5" or greater shall be dimensioned from column grids or building lines. Alternately, provide electronically using .pdf markup of contract drawings.

#### 1.11 DEMONSTRATION

- A. General: After installation is complete, demonstrate to Engineer and Owner's Authorized Representative satisfaction as being complete and operational and entirely in conformance with Contract Documents.
- B. Preparation: Prior to demonstration, submit check-off list indicating completeness of submittals and certificates of compliance for review to Owner's Authorized Representative. Operate completed system for one week. Verify that control verification is complete and verification report has been approved by Architect/Engineer.
- C. Arrange for demonstration with Owner, Engineer, required factory technicians, and installer at least one week in advance of demonstration.

# 1.12 TRAINING

A. Instruct Owner in proper operation and maintenance of equipment and systems. Instruction shall generally include topics listed in manufacturer's operations and maintenance manual. Operator instructions shall cover all aspects of manual, automatic, and safety controls. Contractor shall

also instruct the Owner in the general configuration of systems and location of equipment and components.

- B. Furnish competent qualified technicians knowledgeable in the building electrical and lighting systems and equipment provided for this project for a minimum of 8 hours on-site to instruct Owner in operation and maintenance of systems and equipment. This figure does not include additional training noted under individual specification sections. Contractor shall keep a log of this instruction including date, times, subjects, and those present and shall present such log when requested by Engineer. Contractor shall coordinate training with Owner's Project Manager and provide a schedule for training minimum two-weeks prior to Substantial Completion. All training shall be complete 30-days after Substantial Completion.
- C. Contractor shall furnish training by equipment manufacturers in addition to training described in this section where specifically listed in other sections. Contractor shall schedule training with Owner's Project Manager minimum 48-hours prior to training session. Equipment shall be fully operational prior to scheduling training session. Manufacturer's field start-up, adjustment, and service will not fulfill manufacturer's training requirement.

## 1.13 COORDINATION DOCUMENTS

- A. General Contractor to lead trade coordination. HVAC to be responsible for Building Information Management (BIM) modeling and coordination of equipment, piping and duct systems specified in Division 23. Coordinate with fire protection trade incorporation of Division 21, plumbing trade incorporation of Division 22, and electrical trades incorporation of Divisions 26 through 28.
- B. Prior to commence of construction provide detailed BIM model and layout drawings of equipment, lighting, conduit, and cable tray systems. Coordinate services installation with building architectural components including finishes, structural systems, and ceiling systems.
- C. Preparation of documents:
  - 1. Perform modeling in Revit, Navisworks, or Autodesk BIM 360 Glue.
  - 2. Incorporate addenda, changes, field adjustments and RFIs into model.
  - 3. Submit model with Record documents at project closeout.
- D. Notify architect of Construction Document discrepancies and conflicts where installation requirements require greater space than is available and cannot be resolved through trade coordination efforts alone.
  - 1. Model/drawings level of detail to include the following components:
    - a. Lighting, transformer, switchgear, panelboards, generators, conduits 2" and larger.
    - b. All conduit sizes of panelboard feeders and branch circuit conduits 2" and larger.
    - c. Cable trays, IT equipment and UPS
    - d. Equipment disconnects.
    - e. Networked lighting control equipment.
    - f. Audio/visual equipment.

## 1.14 WARRANTY

- A. Warrant all Work included in this Specification for a period of one year form the date of substantial completion, under provisions of Division 1.
- B. During warranty period, remedy without delay or expense to Owner any defects providing, in judgement of Engineer, that such defects are not result of misuse or abuse on part of Owner.
- C. Warrant that all equipment and installations are in compliance with OSHA regulations.

# PART 2 - PRODUCTS

# 2.1 PRODUCTS AND MATERIALS

- A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.
- B. Equipment used as the basis of design is scheduled on Drawings or designated in product specifications. If Contractor chooses to use equipment that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.

## 2.2 ELECTRICAL EQUIPMENT

- A. Electrical Disconnect Switch: Electrical disconnect switches specified for mechanical equipment shall conform to OSHA Lock-out/Tag-out requirements.
- B. All electrical equipment shall be listed as approved for its application by the Underwriters Laboratory or other testing agency approved by the State of Oregon Electrical and Elevator Board. Approval indicates agency meets testing standard requirements for electrical safety required by Oregon Revised Statutes 479.510 through 479.855 and Oregon Administrative Rules.
- C. Enclosure: Provide the following electrical equipment enclosure types.
  - 1. NEMA 1: Dry, enclosed locations where the ambient temperature will not be outside of the equipment temperature ratings.
  - 2. NEMA 12: Enclosed mechanical spaces equipped with floor drains where dripping or splashing may occur and where the ambient temperature will not be outside of the equipment temperature ratings.
  - 3. NEMA 3R: Outdoors or in spaces where sustained water spray is possible.
  - 4. NEMA 3R: with Temperature Control: Outdoors or in unconditioned spaces where ambient temperatures will be outside of the equipment temperature ratings.
  - 5. NEMA 4X: Outdoors or in spaces that are corrosive environments.

## 2.3 EQUIPMENT CONNECTIONS

- A. Provide a complete electrical connection for all items of equipment including incidental wiring, materials, devices, and labor necessary for a complete operating system. The location and method for connection to each item of equipment shall be verified prior to rough-in. The voltage and phase of each item of equipment shall be checked prior to connecting. Motor rotations shall be made in the proper direction. Pump motors are not to be test run until liquid is in the system and proper lubrication to all bearings in unit is checked.
- B. Conduit, wire, and circuit breaker sizes for mechanical and similar equipment are based on the equipment ratings of one manufacturer. The equipment actually furnished may have different electrical characteristics. Conduit, wire, and circuit breakers shall not be ordered or installed until exact electrical requirements are obtained. The Contractor is responsible for this coordination.

## 2.4 FIRESTOPPING

- A. See Section 07 8413 "Penetration Firestopping".
- B. Acceptable Manufacturers: 3M, Hilti, Tremco, Nelson Firestop Products.
- C. Provide firestopping for the following:
  - 1. All penetrations through fire resistance rated floors, walls and partitions including openings containing pipes, ducts and other penetrating items.
  - 2. All penetrations through non-fire resistance rated floors where the vertical service riser penetrates three or more floors.
- D. Firestop system shall be UL Classified for the application and correspond to those indicated by reference to designation listed by UL Fire Resistance Directory.
- E. Material shall be tested in accordance to UL-1479, ASTM E-814 for the specific fire-rated construction conditions confirming to construction assembly type, penetration item type, annular space requirements, and fire-rating involved.

# 2.5 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS+

- A. Acceptable Manufacturers: J.L. Industries, Karp Associates, Inc., Meadowcraft, Inc., Milcor Div., Inryco, Inc., or Nystrom, Inc.
- B. Application: Match access door to wall or roof assembly fire rating.
- C. Access Door Assembly: Continuous welded steel construction unless otherwise indicated. Grind exposed welds smooth and flush with adjacent surfaces. Provide anchors and attachments necessary for installation indicated.
  - 1. Frames: 16-gage steel; provide flange type necessary for the installation required.
  - 2. Stainless Steel Frames and Flush Panel Doors: 14 gage stainless steel, No. 4. satin finish, concealed spring hinges or concealed piano hinge set to open 175 degrees.
  - 3. Flush Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees

- 4. Lock: Screwdriver-operated cam locks, number required to hold door flush when closed.
- 5. Ceiling Doors: Recessed door panel depth necessary to finish ceiling insert and install flush to adjacent finish ceiling. Reinforced 18 gage sheet steel face. Provide access sleeves for locking devices. Size: As necessary for efficient access, but not less than 24 by 24 inches. Obtain Architect's acceptance of manufacturer's standard size units which vary from sizes indicated.
- D. Fire Rated Units: Comply with NFPA 80, provide UL listed and labeled units having performance level required with insulated flush panel door, continuous piano hinge and self-closing mechanism for rated assemblies in sizes and configuration required.
  - 1. Vertical Doors: NFPA 252 or UL 10B.
  - 2. Horizontal Doors: ASTM E 119 or UL 263.
- E. Shop Applied Coating: Corrosion resistant prime paint compatible with field applied finish specified in Section 09 9100.
- F. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 tested according to the following test method:
  - 1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
  - 2. NFPA 288 for fire-rated access door assemblies installed horizontally.

# PART 3 - EXECUTION

## 3.1 EARTH MOVING

- A. Excavation
  - 1. Contact utilities before starting any excavation to locate underground services on site or in adjacent streets.
  - 2. Locate and protect any existing underground services.
  - 3. Repair any services damaged.
- B. Trenching and Backfilling
  - 1. Provide trenching and backfilling to depth required for underground conduit, per NEC and/or Utility requirements, 36 inches minimum.
  - 2. Backfilling prior to inspection of installation by Owner's Authorized Representative and serving Utility not permitted.
  - 3. Minimum backfill requirements:
    - a. Raceways run beneath building slabs, beneath areas to be paved and beneath streets and sidewalks.
      - 1) Use 1/4 inch to 1-inch diameter, crushed or clean round river rock.
    - b. Underground raceway runs at all other locations.
      - 1) Backfill in compacted layers not exceeding 6 inches in depth.

- 2) Use sand or "clean" earth free form rock larger than 1 inch in diameter and debris.
- c. Provide one continuous #14 copper conductor as a tracing conductor for locating the conduits in the future. Install the tracing conductor at the center line of the upper-most conduit in the trench. Install one tracing conductor in each conduit trench for each 4-foot trench and one for each additional trench width of less than 4 feet wide. (i.e., provide one for a trench up to 4-feet wide, two for 5-8 feet wide, three for 9-12 feet wide, etc.). Provide a 6-foot coil of tracing wire at each end of the trench clearly marked on an identification tag: "TRENCH TRACING CONDUCTOR". Also include the tracing conductor designation and description of the conduits/conductors in the trench. The identification tag shall be machine generated text, enclosed in a waterproof clear plastic seal, and attached to the coil by means of a tie wrap.
- C. Trenching and Backfilling for Services:
  - 1. Coordinate with all utilities for joint trench service Work.
  - 2. Uncover existing utilities by hand digging only.
  - 3. Size to accommodate all utility service conduits and accessories.
- D. Power digging only in direction away from existing facilities.
- E. Route trenching in manner to avoid weakening footings.
- F. Restore, to Architect's and Owner's Authorized Representative's satisfaction at no additional expense, any sidewalks, landscaping, or other existing structure damaged due to excavation.

# 3.2 ACCESS TO EQUIPMENT AND ACCESSORIES

- A. Install equipment with sufficient access for service. Where not conveniently accessible by other means, provide adequately sized access doors for junction & pull boxes, relays & power packs, and all other electrical equipment requiring access for removal or maintenance. Type, size, and exact location of access doors shall be coordinated with Architect prior to work.
- B. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer's recommendations, provide larger clearance of the two.
- C. If equipment location shown on Drawings does not allow required access, notify Architect/ Engineer prior to start of work.
- D. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to Architect/Engineer for resolution prior to starting work.
- E. Provide access doors as required for access to electrical equipment. Doors required for access are not necessarily shown on Drawings. Consult with Architect for direction on placement of required doors not shown on Drawings.

1. Comply with manufacturer's instructions for installation of access doors. Provide all necessary support and supplemental framing for assembly where the access doors are required. Set accurately in position, plumb, level, and flush to adjacent finish surfaces; and secure to support.

# 3.3 ARRANGEMENT AND INSTALLATION OF ELECTRICAL EQUIPMENT AND CONDUIT

- A. Coordinate location of conduit, sleeves, inserts, hangers, cable trays and equipment. Locate conduit, sleeves, inserts, hangers, cable tray and equipment clear of windows, doors, openings, lights, ducts, piping, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Equipment and Conduit Support: Coordinate structural systems necessary for conduit and equipment support with pipe and equipment locations to permit proper installation.
- C. Location of conduit sleeves, trenches and chases shall be accurately coordinated with equipment and conduit locations.
- D. Minor Conduit: Small diameter conduit runs from receptacles, lighting, equipment, and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor conduit where needed to maintain electrical spaces clean and neat and to allow full equipment function and maintenance.
- E. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Owner's Authorized Representative. Locate openings that will least affect structural slabs, columns, ribs, or beams. Refer to the Architect/Engineer for determination of proper design for openings through structural sections and obtain layout approval prior to cutting or drilling into structure. After Architect/Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
- F. Inaccessible Equipment
  - 1. Where the Owner's Authorized Representative determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
  - 2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

# 3.4 RIGGING

- A. Design is based on use of available structure without modification except as specifically shown. Existing openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Architect/Engineer under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.

- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Owner's operation and maintenance.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Where it is not clear that the building structure has adequate capacity to support rigging, Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to existing building structure, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- E. Restore building to original condition upon completion of rigging work.

#### 3.5 EXISTING EQUIPMENT REUSED OR RELOCATED

A. All equipment designated as existing or furnished by Owner shall be cleaned and repaired before reinstallation. Any items requiring repair shall be brought to the attention of the construction manager before the item is reinstalled. Damage not brought to the attention of the construction manager shall be deemed the result of reinstallation of the item and shall be repaired without expense to the Owner.

## 3.6 ELECTRICAL SYSTEMS FIRESTOPPING

- A. Do not cover firestop installations until they are examined by the Authority Having Jurisdiction, if required.
- B. Install firestopping in accordance with manufacturer's recommendations and conditions of product UL listing.

## 3.7 CLEANING SYSTEMS

- A. General: After all equipment, conduits and cable tray are installed, system shall be thoroughly cleaned. Remove all nonessential stickers and labels from equipment or fixtures. Clean all light fixture lenses. Clean interior of conduit systems prior to installation of wiring.
- B. Repair or replace any discolorations or damage to systems, building finish, or furnishings resulting from Contractor's failure to properly clean system.

# 3.8 START UP

- A. The Electrical Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration, and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.
- B. Start equipment in accordance with manufacturer's recommendations and under manufacturer's supervision where required. Ensure that associated breakers, relays, electrical overloads, and other devices intended to protect the equipment are installed and functional prior to startup.

# 3.9 EXTRA STOCK

A. Provide extra stock, as described in individual sections, to Owner in accordance with Division 1

END OF SECTION 26 0500

# SECTION 26 0501 - ELECTRICAL DEMOLITION

#### PART 1 - GENERAL

## 1.1 SCOPE

- A. It is the intent of these documents to provide the necessary information and adjustments to the electrical system required to meet Code and accommodate installation of the new work.
- B. Contractor shall coordinate with the Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas. The Owner will cooperate to the best of their ability to assist in a coordinated schedule but will remain the final authority as to time of work permitted.

#### 1.2 EXISTING CONDITIONS

A. The locations of existing utilities and equipment are shown in an approximate way only and have not been independently verified by the Owner or its representative. The Contractor shall determine the exact location of all existing utilities before commencing work and agrees to be fully responsible for any and all damages which might be occasioned by the Contractor's failure to exactly locate and preserve any and all utilities and equipment. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on the Drawings.

#### PART 2 - PRODUCTS

#### 2.1 MATERIALS

A. All materials accumulated during the demolition process are the Owner's property and shall be removed from the job site as directed by the Owner.

#### PART 3 - EXECUTION

#### 3.1 DEMOLITION

- A. Remove all existing fixtures, clocks, switches, receptacles, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless specifically shown as retained or relocated on the Drawings.
- B. Disconnect all existing mechanical equipment scheduled for removal, relocation or abandonment. See mechanical drawings for scope of work. Remove abandoned cables and unusable raceways. Relabel panels and motor control centers to reflect changes.
- C. Maintain electrical continuity of all existing systems. Remove or relocate electrical boxes, conduit, wiring, equipment, fixtures, etc. as may be encountered in removed or remodeled areas in the existing construction affected by this work. Wiring which serves usable existing outlets shall

be removed and restored clear of the construction or demolition. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, new conduit and wire shall be provided to bypass the abandoned outlets. If existing conduits pass through partitions or ceiling which are being removed or remodeled, new conduit and wire shall be provided to reroute clear of the construction or demolition and maintain service to the existing load.

- D. Extend circuiting and devices in all existing walls to be furred out.
- E. Existing electrical outlets and light fixtures are denoted by dotted or dashed lines. Verify exact location of existing electrical outlets and light fixtures in the field. Only partial existing electrical shown. Locations of items shown on the Drawings as existing are partially based on as-built and other drawings which may contain errors. The contractor shall verify the accuracy of the information shown prior to bidding and provide such labor and material as is necessary to accomplish the intent of the contract documents.
- F. Remove all abandoned wiring to leave site clean.
- G. Keep outages to occupied areas to a minimum and prearrange all outages with the Owner's representative. Requests for outages shall state the specific dates and hours and the maximum durations, with the outages kept to these specific dates and hours and the maximum durations. This Contractor will be liable for any damages resulting from unscheduled outages or for those not confined to the preapproved times. Outages shall take place at times when the facility is not in operation or occupied by non-essential personnel. Include all costs for overtime labor as necessary to maintain electrical services in the initial bid proposal. Temporary wiring and facilities, if used, shall be removed and the site left clean before final acceptance. Requests for outages must be submitted at least (5) days prior to intended shutdown time.
- H. No circuit breaker or disconnects shall be turned off without prior approval from Owner. Coordinate with the Owner's representative responsible for the area or equipment affected for any electrical interruptions which affect the operation of the remaining portions of the facility.
- I. Verify with the General Contractor a location for storage of materials, supplies, tools, rubbish, etc. prior to start of work.

END OF SECTION 26 0501

# SECTION 26 0519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 - GENERAL

- 1.1 SECTION INCLUDES
  - A. Wires and Cables
  - B. Wire Connections

#### 1.2 REFERENCE STANDARDS

- A. National Fire Protection Association (NFPA)
  - 1. NFPA 70 National Electrical Code

# 1.3 SUBMITTALS

- Provide submittals for products listed in the Product Table below in accordance with Section 26 0500 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Conductor and cable materials		Х						
Twist-on connector		Х						
Compression adapter		Х						
Terminal, crimp on		Х						

#### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver new wire to Site in new standard coils or reels with approved tag denoting length, wire size, insulation type and manufacturer's name.
- B. Protect from weather and damage during storage and handling.

#### PART 2 - PRODUCTS

# 2.1 CONDUCTOR AND CABLE MATERIALS

- A. Building Wiring: 98 percent conductivity copper, 600-volt insulation, stranded. Type THHN for interior dry and damp locations. Type THWN or XHHW for wet and exterior locations.
- B. Branch Circuit Wiring: Conductors smaller than No. 12 AWG for power system branch circuits not permitted.
- C. Motor control wires shall be No. 14 minimum.
- D. Wire for special areas shall be as specified on the Drawings.
- 2.2 TWIST-ON CONNECTOR
  - A. UL pressure-type, solderless, insulated, wound spring grip twist on connector.
  - B. Solderless pressure connectors for terminals, taps, and splices.
- 2.3 COMPRESSION ADAPTER
  - A. For terminating a single aluminum wire into mechanical connectors, such as a circuit breaker or set screw lugs. Burndy "Hyplug" Type AYP, or approved equal by Anderson, Illsco, Kearney, Mac-Adapt, T&B.
- 2.4 TERMINAL, CRIMP-ON
  - A. Flat, fork tongue, self-insulating.
  - B. For connection of stranded wire to screw terminals.
  - C. T & B "Sta-Kon," or approved equal.

## PART 3 - EXECUTION

- 3.1 CONDUCTOR AND CABLE INSTALLATION
  - A. Make conductor length for parallel feeders identical.
  - B. Lace or clip groups of feeder conductors at distribution centers, pullboxes, and wireways.
  - C. Provide copper grounding conductors and straps. A ground wire shall be pulled through conduits and used as the equipment grounding conductor.
  - D. Use 10 AWG conductors for 20 ampere, 120 volt branch circuit home runs longer than 100 feet, and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet. Neutral conductor shall be sized the same as corresponding "hot" conductors.
  - E. No shared neutrals. Provide one neutral for each phase conductor in branch circuits.
  - F. Wire and cable shall be brought to the job in the original containers bearing the U.L. label.
  - G. Install wire and cable in code conforming raceway.

- H. Use wire pulling lubricant for pulling No. 4 AWG and larger wire. UL approved type only.
- I. Install wire in conduit runs after concrete and masonry work is complete and after moisture is swabbed from conduits.
- J. Couplings and conduit connectors shall have pre-insulated bushings in place before pulling wires.
- K. Splice only in accessible junction or outlet boxes. Splice in feeders and services not permitted. Splices or taps in branch circuits permitted only in junction boxes where circuits divide.
- L. Color code conductors to designate neutral, phase, and ground as follows:

	120/208 OK					
CONDUCTOR	120/240	277/480				
Phase A	Black	Brown				
Phase B	Red	Orange				
Phase C	Blue	Yellow				
Neutral	White	Gray				
Ground	Green	Green				
Switchlegs	Pink	Pink				
Travelers	Purple	Purple				
Fire Alarm	Red					
Intercom/Clock/Bell	Grey					
Security	Orange					
HVAC Control	Green					
Data/Telecom	Blue (CAT6)					

- M. Wires shall be factory color coded by integral pigmentation. Colored plastic tape permitted on No. 6 and larger where integral pigmentation impractical. Apply tape in spiral half-lap over exposed portions in manholes, boxes, panels, switchboards and other enclosures.
- N. All circuit conductors shall be identified with circuit number at all terminals, intermediate outlets, disconnect switches, circuit breakers, motor control centers, etc. Both ends of a given conductor shall be identified alike.
- O. DO NOT install wires of different voltage systems in same raceway, box, gutter or other enclosure.
- P. Radius of cable bends shall not be less than 10 times the outer diameter of the cable.
- 3.2 CONNECTIONS AND SPLICES
  - A. Follow manufacturer's instructions using manufacturers recommended tools.
  - B. Stripping Insulation: Carefully strip, avoid nicking conductor. No "ringing."
  - C. Design: Connectors shall be designed and approved for the purpose used. Connectors between aluminum and copper shall be listed "AL/CU" for the purpose of preventing electrolytic action.
  - D. Bare Connectors and Conductor Free Ends: Wrap with insulating rubber or friction tape to equivalent insulation of wire.

- E. Ground Continuity to Metallic Surfaces: Remove any paint coating and polish surface beneath connection.
- F. Copper conductors may be terminated in any approved compression or mechanical connector, including set screws.
- G. No splices or taps permitted in feeder or branch circuit terminating in a single outlet.
- H. Branch circuit splices and taps in junction and outlet boxes: Twist-on connectors.
- I. Conductor and cable copper shall not be reduced at the terminal for making connections.
- J. Slack shall be left at equipment, pullboxes, or outlet boxes to allow for a neat termination.

## END OF SECTION 26 0519

## SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

- 1.1 SECTION INCLUDES
  - A. Electric and power system grounding
  - B. Communication system grounding

#### 1.2 REQUIREMENTS OF REGULATORY AGENCIES

- A. Provide grounds in accordance with National Electrical Code and additional requirements as required herein.
- B. NEC references below are based on the 2017 edition and State of Washington, Electrical Safety Standards, Administration and Installation WAC 296-46B

## 1.3 SUBMITTALS

- Provide submittals for products listed in the Product Table below in accordance with Section 26 0500 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Grounding conductors		Х						

#### PART 2 - PRODUCTS

#### 2.1 GROUNDING CONDUCTORS

- A. Size: Grounding Electrode Conductor: Table 250-66. Equipment grounding conductor: Table 250-122.
- B. Material: Copper.
- C. Protection: Conductors not in raceway or concealed shall be insulated. Provide conduit where shown or required for physical protection.

D. Bonding Jumpers: Same requirements.

# PART 3 - EXECUTION

## 3.1 POWER SYSTEM GROUNDING

- A. All main building grounding shall be non-reversible connections using exothermic welding or compression.
- B. Circuit Grounding: Install grounding bushings, studs, and jumpers at distribution centers, pullboxes, motor control centers, panelboards, and junction boxes.
- C. Ground Connections: Clean surfaces thoroughly before applying ground lugs or clamps. If surface is coated, the coating must be removed down to the bare metal. After the coating has been removed, apply a noncorrosive approved compound to cleaned surface and install lugs or clamps. Where galvanizing is removed from metal, it shall be painted or touched up.
- D. Conduit Systems:
  - 1. Ground all metallic conduit systems.
  - 2. Non-metallic conduit systems shall contain a grounding conductor.
  - 3. Conduit provided for mechanical protection containing only a grounding conductor, bond to that conductor at the entrance and exit from the conduit.
- E. Feeders and Branch Circuits: Install green grounding conductors with feeders and branch circuits as follows:
  - 1. Feeders
  - 2. Circuits serving preparation and kitchen equipment
  - 3. Receptacle outlets
  - 4. Directly connected laboratory equipment
  - 5. Motors and motor controllers
  - 6. Fixed equipment and appliances
  - 7. Items of equipment where the final connection is made with flexible metal conduit shall have a grounding wire
  - 8. Additional locations and systems as shown
- F. Boxes, Cabinets, Enclosures, and Panelboards:
  - 1. Bond the grounding wires to each pullbox, junction box, outlet box, cabinets, and other enclosures through which the ground wires pass (except for special grounding systems for intensive care units and other critical units shown.
  - 2. Provide lugs in each box and enclosure for ground wire termination.
  - 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs for terminating the ground wires.
- G. Receptacles: Refer to Section 26 2726 WIRING DEVICES.
- H. Ground lighting fixtures to the green grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures

connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

I. Cross off with indelible ink as bolts are torqued to specifications. Maintain Torque Log Sheets as proof of proper installation practice of Torqueing of grounding bolts.

# 3.2 COMMUNICATION SYSTEM GROUNDING CONDUCTOR

- A. Use minimum 6 AWG copper conductor.
- B. Leave 10 feet slack conductor at terminal board.

END OF SECTION 26 0526

## SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Steel slotted support systems.
  - 2. Aluminum slotted support systems.
  - 3. Nonmetallic slotted support systems.
  - 4. Conduit and cable support devices.
  - 5. Support for conductors in vertical conduit.
  - 6. Structural steel for fabricated supports and restraints.
  - 7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
  - 8. Fabricated metal equipment support assemblies.
- B. Related Requirements:
  - 1. Section 26 0548 "Seismic Control for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Slotted support systems, hardware, and accessories.
    - b. Clamps.
    - c. Hangers.
    - d. Sockets.
    - e. Eye nuts.
    - f. Fasteners.
    - g. Anchors.
    - h. Saddles.
    - i. Brackets.
  - 2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
  - 1. Hangers. Include product data for components.
  - 2. Slotted support systems.
  - 3. Equipment supports.
  - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for electrical systems.
  - 1. Include design calculations and details of hangers.
  - 2. Include design calculations for seismic restraints.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Ductwork, piping, fittings, and supports.
  - 3. Structural members to which hangers and supports will be attached.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Projectors.
- B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding certificates.

## 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:

- 1. AWS D1.1/D1.1M.
- 2. AWS D1.2/D1.2M.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified."
  - 2. Component Importance Factor: 1.5.
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame Rating: Class 1.
  - 2. Self-extinguishing according to ASTM D 635.

## 2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inchdiameter holes at a maximum of 8 inches o.c. in at least one surface.
  - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  - 2. Material for Channel, Fittings, and Accessories: Galvanized steel.
  - 3. Channel Width: Selected for applicable load criteria.
  - 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
  - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
  - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 6. Toggle Bolts: All-steel springhead type.
  - 7. Hanger Rods: Threaded steel.

# 2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 5000 "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

## 3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  - 1. NECA 1.
  - 2. NECA 101
  - 3. NECA 102.
  - 4. NECA 105.
  - 5. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

# 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

## 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 5000 "Metal Fabrications" for site-fabricated metal supports.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

## 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

#### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099100 "Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## END OF SECTION 26 0529

# SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal conduits and fittings.
  - 2. Nonmetallic conduits and fittings.
  - 3. Metal wireways and auxiliary gutters.
  - 4. Nonmetal wireways and auxiliary gutters.
  - 5. Surface raceways.
  - 6. Boxes, enclosures, and cabinets.
  - 7. Handholes and boxes for exterior underground cabling.

#### 1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.
- 1.4 ACTION SUBMITTALS
  - A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
  - B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

# PART 2 - PRODUCTS

# 2.1 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Allied Tube & Conduit; a part of Atkore International.
    - b. Calconduit.
    - c. Thomas & Betts Corporation; A Member of the ABB Group.
    - d. Western Tube and Conduit Corporation.
    - e. Wheatland Tube Company.
  - 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. GRC: Comply with ANSI C80.1 and UL 6.
  - 4. IMC: Comply with ANSI C80.6 and UL 1242.
  - 5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - a. Comply with NEMA RN 1.
    - b. Coating Thickness: 0.040 inch, minimum.
  - 6. EMT: Comply with ANSI C80.3 and UL 797.
- B. Metal Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Allied Tube & Conduit; a part of Atkore International.
    - b. O-Z/Gedney; a brand of Emerson Industrial Automation.
    - c. Thomas & Betts Corporation; A Member of the ABB Group.
    - d. Western Tube and Conduit Corporation.
    - e. Wheatland Tube Company.

- 2. Comply with NEMA FB 1 and UL 514B.
- 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
- 5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
- 6. Fittings for EMT:
  - a. Material: Steel.
  - b. Type: Setscrew.
- 7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Nonmetallic Conduit:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Anamet Electrical, Inc.
    - b. CANTEX INC.
    - c. Kraloy.
    - d. Thomas & Betts Corporation; A Member of the ABB Group.
  - 2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. ENT: Comply with NEMA TC 13 and UL 1653.
  - 4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
  - 5. LFNC: Comply with UL 1660.
- B. Nonmetallic Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Anamet Electrical, Inc.
    - b. CANTEX INC.
    - c. Kraloy.

- d. RACO; Hubbell.
- e. Thomas & Betts Corporation; A Member of the ABB Group.
- 2. Fittings, General: Listed and labeled for type of conduit, location, and use.
- 3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
  - a. Fittings for LFNC: Comply with UL 514B.
- 4. Solvents and Adhesives: As recommended by conduit manufacturer.

# 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. B-line, an Eaton business.
  - 2. Hoffman; a brand of nVent.
  - 3. MonoSystems, Inc.
  - 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R unless otherwise indicated, and sized according to NFPA 70.
  - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

## 2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Wiremold / Legrand.
    - b. Hubbell Incorporated; Wiring Device-Kellems.
    - c. MonoSystems, Inc.
    - d. Panduit Corp.

#### 2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Crouse-Hinds, an Eaton business.
  - 2. FSR Inc.
  - 3. Hoffman; a brand of nVent.
  - 4. Hubbell Incorporated.
  - 5. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 6. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
  - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep minimum.
- L. Gangable boxes are allowed.
- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Plastic.
  - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

- N. Cabinets:
  - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.
  - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 1. Standard: Comply with SCTE 77.
  - 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 5. Cover Legend: Molded lettering, "ELECTRIC.".
  - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  - 7. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Hubbell Incorporated (Quazite).
    - b. Oldcastle Precast, Inc.
  - 2. Standard: Comply with SCTE 77.
  - 3. Color of Frame and Cover: Gray.
  - 4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  - 5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

- 7. Cover Legend: Molded lettering, "ELECTRIC."
- 8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- 9. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by an independent testing agency.
  - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

# PART 3 - EXECUTION

# 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC.
  - 2. Concealed Conduit, Aboveground: GRC, IMC or Type EPC-40-PVC.
  - 3. Underground Conduit: Type EPC-40-PVC.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
  - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
  - 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
    - d. Gymnasiums.
  - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  - 6. Damp or Wet Locations: GRC or IMC.
  - 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic in institutional and commercial kitchens and damp or wet locations.

- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
  - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  - 3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
  - 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

## 3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
  - 5. Change from ENT to GRC or IMC before rising above floor.
- M. Stub-Ups to Above Recessed Ceilings:
  - 1. Use EMT, IMC, or RMC for raceways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- V. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Conduit extending from interior to exterior of building.
  - 4. Conduit extending into pressurized duct and equipment.
  - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - 6. Where otherwise required by NFPA 70.
- Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Z. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install

fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

- 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
- 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 48 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement, and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- EE. Locate boxes so that cover or plate will not span different building finishes.
- FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- HH. Set metal floor boxes level and flush with finished floor surface.
- II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

# 3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 2000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
  - 2. Install backfill as specified in Section 31 2000 "Earth Moving."
  - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12

inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

- 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
- 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
- 6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
- 7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

# 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

# 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install 0sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

# 3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413 "Penetration Firestopping."

# 3.7 **PROTECTION**

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 0533

# SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

# PART 1 - GENERAL

- 1.1 SECTION INCLUDES
  - A. Nameplates
  - B. Wire and cable markers
  - C. Pull box and junction box identification
  - D. Device plate identification

# 1.2 REQUIREMENTS OF REGULATORY AGENCIES

A. Identification shall conform to the latest edition of the National Electrical Code (NEC), Articles 110-21 and as a minimum requirement.

# 1.3 SUBMITTALS

- Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions
  - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Engraved laminated plastic		Х						
Adhesive film labels		Х						

## PART 2 - PRODUCTS

- 2.1 MATERIALS
  - A. Nameplates:
    - 1. Three-layer, white front and back with black core laminated plastic.
    - 2. Engraved through outer layer to show white characters on black background.
    - 3. Beveled edges.
    - 4. NEC Article 700 Systems (Lighting Inverter)

- a. Same nameplate requirements listed above, but with orange nameplate white characters for emergency systems distribution equipment.
- B. Wire and Cable Markers:
  - 1. Heat shrink thermo-labels
  - 2. Brady or Panduit
- C. Labels:
  - 1. Adhesive Film Labels: Machine printed, in black on clear background, by thermal transfer or equivalent process
  - 2. Emergency receptacles/wall switches: Black on red background
- D. Panelboard Directory Card: Fiberboard neatly typed for newly installed panels. Circuit changes to existing panels shall be noted on the directory card by hand printing in ink. When more than five changes have been made on the directory card, a new card shall be typed.

# PART 3 – EXECUTION

- 3.1 GENERAL
  - A. During finish construction, labeling is to be reviewed and approved by the Owner.
  - B. Zoned systems must be clearly defined and labeled.
  - C. Label at all entries into new spaces and/or through walls.
  - D. Covering or painting of any sign/label requires replacement.
  - E. Mark and label new wiring and place in tray. Include installation date.
- 3.2 NAMEPLATE INSTALLATION
  - A. Degrease and clean surfaces to receive nameplates.
  - B. Install nameplates parallel to equipment lines.
  - C. Secure nameplates to equipment fronts using screws or drive rivets.
    - 1. Secure nameplate to inside face of recessed panelboard doors in finished locations.
    - 2. Secure nameplate to outside face of panelboards in unfinished locations.
  - D. Where switches control remote lighting or power outlets, or where switches in the same outlet (two or more) serve different purposes such as lights, power, intercom, etc., or different areas such as corridor and outside, furnish either engraved nameplates or adhesive film labels with 1/4-inch black letters indicating function of each switch or outlet.
  - E. Use adhesive film labels for identification of individual wall switch and receptacle cover plates.

# 3.3 WIRE IDENTIFICATION

- A. Labeling shall be non-destructible type which may not be removed during installation.
- B. Provide wire markers on each conductor in panelboards, gutters, pull boxes, and at load connection.
- C. Identify with branch circuit or feeder number for power and lighting circuits.
- D. Tag lighting feeds with circuit number and panel ID.
- E. Identify control wire number as indicated on equipment manufacturer's shop drawings.

# 3.4 NAMEPLATE ENGRAVING SCHEDULE

- A. Identify all electrical distribution, control equipment and disconnect switches at loads served.
- B. 3/4-inch nameplates are to be fastened with sheet metal screws.
- C. Disconnect switches and control units shall include circuit number and panel ID.
- D. Letter Height:
  - 1. 1/2-inch for individual switches and loads served.
  - 2. 1/2-inch for distribution and control equipment identification.
  - 3. 1/2-inch identifying voltage rating and source.
- E. Transformers:
  - 1. 1/2-inch; identifying equipment designation.
  - 2. 1/2-inch; identifying primary source, and secondary load and location.
- F. Automatic Transfer Switches shall have a red background with 1/2-inch white lettering.

## 3.5 PULL BOX AND JUNCTION BOX IDENTIFICATION

- A. Provide permanent signage, interior and exterior at all utility boxes, vaults, manholes, etc.
- B. Install labels on inside of junction boxes and adhesive film label on the box cover.
- C. Identify each junction box with complete system description. Examples:
  - 1. Fire alarm
  - 2. Telephone
  - 3. 480V system
  - 4. 208V system
- D. Methods:
  - 1. Neat hand lettering with permanent black marker
  - 2. Engraved nameplates
  - 3. Adhesive film labels

- E. Emergency power junction boxes and conduit (NEC Article 700 Systems):
  - 1. Paint emergency power junction boxes and conduits orange and label junction boxes "EMERGENCY" and identify circuits prior to installation.
- F. Fire alarm junction boxes:
  - 1. Paint fire alarm junction boxes and covers red and label "FIRE ALARM" prior to installation.
- G. Locations:
  - 1. On outside of box cover where concealed.
  - 2. In exposed box locations, locate on inside of box cover.
  - 3. Identify main pull boxes by number and indicate numbers on record drawings.

# 3.6 DEVICE PLATE IDENTIFICATION

- A. 1/4-inch letter height.
- B. Black letter color.
- C. Location:
  - 1. Bottom center of device plate for single gang and multiple gang outlets.
    - a. Provide branch circuit identification (example: "B-16" indicating panel "B" circuit #16).

## END OF SECTION 26 0553

# SECTION 26 2726 - WIRING DEVICES

# PART 1 – GENERAL

- 1.1 SECTION INCLUDES
  - A. Wall Switches
  - B. Receptacles
  - C. Ground Fault Receptacles
- 1.2 REFERENCE STANDARDS
  - A. American National Standards Institute (ANSI)
    - 1. 467 Grounding and Bonding Equipment (ANSI/UL467)
    - 2. 498 Attachment Plugs and Receptacles (ANSI/UL498)
    - 3. C73 Series Dimensions of Attachment Plugs and Receptacles
  - B. Federal Specification (FS)
    - 1. W-C-596D and E Specification for Electrical Power Connector, Plug, Receptacle and Cable Outlet.
  - C. National Electrical Manufacturer's Association (NEMA)
    - 1. WD 1-79 General Purpose Wiring Devices
  - D. National Fire Protection Association (NFPA)
    - 1. NFPA 70 National Electrical Code
  - E. Underwriters' Laboratory (UL)
    - 1. UL-20 Standard for Snap Switches

# 1.3 SUBMITTALS

- Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams
  - 6. Shop Drawings
  - 7. Installation Instructions

8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Switches			Х					
Duplex receptacles			Х					
Ground fault receptacles			Х					
Wall plates			Х					
Color			Х					

# 1.4 QUALITY ASSURANCE

- A. Receptacles shall be Industry Class 5362.
- B. Acceptable Manufacturers: Hubbell, Leviton, or approved.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Switches: 120/277 Volt. AC Quiet, slow-make, slow break design, toggle handle, with totally enclosed case, rated 20 ampere, heavy duty, industrial grade. Provide matching two-pole, three-way and four-way switches.
- B. Switch and Pilot Light: Toggle action type with red handle, integral long-life neon pilot light, rated at 15 ampere, 120 volts.
- C. Duplex Receptacles: Full gang size, polarized, duplex, parallel blade, U-grounding slot, heavy duty, industrial grade, rated at 20 amperes, 125 volts (unless otherwise noted), designed for split feed service.
- D. Ground Fault Receptacles: Heavy duty, industrial grade duplex receptacle with integral ground fault circuit interrupter. Test and reset buttons. Matching wall plate.
- E. Wall Plates: Satin stainless steel, Type 302. Nominal .040-inch thick. Match device configuration.
- F. Nameplates: Provide engraved or embossed plastic nameplates for receptacles other than standard duplex receptacles indicating voltage, phase, amperes, circuit and panel.
- G. Color: Provide gray switches and receptacles in all areas.
- H. Wiring devices with push-in terminals are not allowed.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

A. Furnish and install wiring devices of number, rating and type shown.

- B. Devices to include appropriate outlet box, cover, wall plate and other necessary installation materials for a complete operating outlet.
- C. Mount switches 48 inches (to top of box) above floor except as otherwise noted on the Drawings.
- D. Coordinate switch mounting location with architectural detail.
- E. Mount receptacles vertically at 18 inches (to center of box) above finished floor, with grounding pole at bottom. Verify exact height and orientation of outlets with Architectural Details prior to rough-in.
- F. Coordinate receptacle height with benches and counters.
- G. When mounting receptacle above bench or counter, mount vertically at height indicated (to center of box) with ground pole down, unless otherwise noted. Verify exact height and orientation of outlets with Architectural Details prior to rough-in.
- H. Back wiring wells may be used for receptacles.
- I. Where outlets are adjacent to each other at same mounting heights, install under common device plate, except where outlet are of different voltages, such as telephone and duplex receptacles, unless otherwise noted.
- J. Grounding: Install a separate green or bare wire between the receptacle strap grounding (green) screw and a screw into the outlet box. Self-grounding strap not approved as grounding means.

END OF SECTION 26 2726

# SECTION 26 2816 - OVERCURRENT PROTECTIVE DEVICES

# PART 1 - GENERAL

- 1.1 SECTION INCLUDES
  - A. Circuit Breakers
- 1.2 REFERENCE STANDARDS
  - A. American National Standards Institute (ANSI)
    - 1. C37.16 Preferred Ratings, Related Requirements, and Application Recommendations for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors
    - 2. C37.17 Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
  - B. Federal Specifications (FS)
    - 1. W-C-375B/GEN Circuit Breakers, Molded Case; Branch Circuit and Service, Federal Supply Classification (FSC) 5925
    - W-C-375 (1 through 20) Circuit Breakers, Molded Case, Branch Circuit and Service (FSC) 5925
  - C. Institute of Electrical and Electronic Engineers, Inc. (IEEE)
    - 1. 20-73 Low Voltage AC Power Circuit Breakers Used in Enclosures (ANSI C37.13-73)
- 1.3 APPLICABLE REGULATIONS
  - A. Underwriters' Laboratories (UL)
    - 1. UL 489-72 Molded Case Circuit Breakers and Circuit Breaker Enclosures
    - 2. UL 869 Service Disconnects
  - B. National Fire Protection Association (NFPA)
    - 1. NFPA 70 National Electrical Code

## 1.4 SUBMITTALS

- Provide submittals for products listed in the Product Table below in accordance with Section 26 0500 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
  - 1. Materials List
  - 2. Catalog Data
  - 3. Product Data
  - 4. Performance Data
  - 5. Wiring Diagrams

- 6. Shop Drawings
- 7. Installation Instructions
- 8. Special Requirement listed herein

PRODUCT TABLE	1	2	3	4	5	6	7	8
Molded case circuit breakers			Х	Х				

# PART 2 - PRODUCTS

# 2.1 MOLDED CASE CIRCUIT BREAKERS

## A. Circuit Breakers:

- 1. Connection to Bus: Bolt-on
- 2. Thermal-magnetic, molded case, with inverse time current overload and instantaneous magnetic tripping unless otherwise shown.
- 3. Quick-make, quick-break, with tripped indication clearly shown by breaker handle taking a position between ON and OFF.
- 4. Multi-pole breakers shall have a common internal trip. No handle ties between single pole breakers.
- 5. Contacts: T-rated, for heavy duty switching applications
- 6. Breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the breaker trip rating to prevent repeated arcing shorts resulting from frayed appliance cords.
- 7. Additions to existing panelboards and switchboards shall match or be compatible with existing.
- 8. Provide handle ties per NEC for breakers serving circuits with shared neutral conductors.
- 9. Where used as service disconnects, breakers shall be listed for use as service entrance equipment.

# PART 3 - EXECUTION

# 3.1 CIRCUIT BREAKER INSTALLATION

- A. Label each breaker located in switchboard or separate enclosure to indicate load served.
- B. Adjust settings on breakers to operate properly under actual field conditions and to provide selective system coordination.
- C. Update directory in panelboards which have new breakers installed.

END OF SECTION 26 2816

# SECTION 27 0000 - COMMUNICATIONS

# PART 1 - GENERAL

# 1.1 DESCRIPTION

- A. Division 27 Communications governs the infrastructure for the low-voltage information transport systems, which include voice and data and their pathways.
- B. The Scope of Work covered by this document is to furnish and install the pathways, bonding and grounding system and finishes for telecommunications spaces. This contract is also responsible for installations of racking and ladder tray in the telecommunications rooms and installation of all telecommunications cabling.
- C. Description of Work:
  - 1. Furnish and install materials for the communications pathway and bonding and grounding systems as specified herein and as shown on the Drawings.
  - 2. The components specified and shown on the Drawings is for complete, performance based, workable systems. Deviations from what is shown due to a particular manufacturer's requirements shall be made only with the written approval of the Architect and the Owner, and at no additional cost to the Owner.
  - 3. Build out of telecommunications rooms (MDF/IDF)
    - a. Racks, ladder trays, cabinets, and associated components
    - b. Bonding to Division 26-provided and -installed telecommunications grounding busbars
  - 4. Installation, termination, and testing of all telecommunications cabling
    - a. All copper category cabling (re-terminate existing copper cabling in upgraded IDF spaces)
    - b. All fiber optic backbone cabling
  - 5. As-built documentation.

# 1.2 WORK COVERED BY THIS DIVISION (27):

- A. Structured Cabling System (SCS) For Telecommunications Systems including buildout of all infrastructure components necessary for telecommunications spaces:
  - 1. Copper and fiber optic backbone cabling and components
  - 2. Re-terminating existing Category 6 & 6A horizontal cabling system.

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- 3. Racks and cabinets.
- 4. Ladder trays within the telecommunications spaces.
- 5. Seismic bracing for telecommunications pathway and components.
- 6. Cable management within the ladder tray, racks, and cabinets.
- 7. Pathways for Telecommunications Systems.
- 8. Grounding and Bonding System (GBS) For Telecommunications Systems.
- 9. Rack mounted power distribution units.
- 10. Firestopping for Telecommunications Systems.
- 11. Testing of all telecommunications cabling system.
- 12. As-built documentation.

# 1.3 ENVIRONMENTAL CONSIDERATION

- A. When at all possible, equipment and materials are to be assembled at Distributors or Contractors location and delivered to construction site without packaging or shipping material.
- B. Except as noted for purposes of recycling, all construction related debris, packaging and waste materials will be removed from the job site each day and disposed of by the Contractor.

## 1.4 SITE SPECIFIC REQUIREMENTS

- A. Contractor must conform to schedule prescribed by General Contractor.
- B. Site details are shown on the accompanying drawings.

# 1.5 SECTION INCLUDES

- A. Related Documents, Codes, and Sections
- B. Abbreviations, Acronyms and Definitions
- C. Project Drawings
- D. Quality Assurance
- E. Submittal Requirements
- F. Additional Requirements

## 1.6 RELATED DOCUMENTS AND CODES

- A. Comply with all Contract Documents. Where conflicts occur, the more stringent shall apply.
- B. Comply with the referenced codes and standards. Where conflicts occur, the more stringent shall apply.

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- C. The latest versions, including addenda, as enforced by the local authority having jurisdiction of the following codes, associations, acts and agencies:
  - 1. Federal Communications Commission (FCC).
  - 2. National Fire Protection Association (NFPA), specifically:
    - a. NFPA 70, National Electrical Code<sup>®</sup> (NEC<sup>®</sup>)
    - b. NFPA 72, National Fire Alarm Code®
    - c. NFPA 76, Recommended Practice for the Fire Protection of Telecommunications Facilities
    - d. NFPA 101, Life Safety Code®
    - e. NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
    - f. NFPA 780, Standard for the Installation of Lightning Protection Systems
    - g. NFPA 5000<sup>TM</sup>, Building Construction and Safety Code
  - 3. National Electrical Safety Code (NESC)
  - 4. Occupational Safety and Health Administration (OSHA)
- D. The following standards bodies:
  - 1. American National Standards Institute (ANSI)
  - 2. National Electrical Manufacturers Association (NEMA)
  - 3. Telecommunications Industry Association (TIA), specifically:
    - a. TIA TSB-125, Guidelines for Maintaining Optical Fiber Polarity through Reverse-Pair Positioning
    - b. TIA TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
    - c. TIA-526-7, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7
    - d. ANSI/TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises
    - e. ANSI/TIA-568.1-D, Commercial Building Telecommunications Infrastructure Standard
    - f. ANSI/TIA-568.2.D, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
    - g. ANSI/TIA-568.3-D, Optical Fiber Cabling and Components Standard
    - h. ANSI/TIA/569 Commercial Building Standard for Telecommunications Pathways and Spaces
    - i. ANSI/TIA-569-D-2015, Telecommunications Pathways and Spaces
    - j. ANSI/TIA/607-D, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - 4. Other Reference Materials
    - a. ANSI C80.1 Rigid Steel Conduit Zinc Coated
    - b. ANSI C80.4 Fittings for Rigid Metal Conduit
    - c. ANSI/NECA/BICSI-568-2006, Standard, Installing Commercial Building Telecommunications Cabling

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- d. ANSI/NECA/BICSI® 568-2006, Standard for Installing Telecommunications Systems
- e. ANSI/NFPA 70, Article 250 Grounding and Bonding
- f. ANSI/NFPA 70, Article 318 Cable Trays
- g. ANSI/NFPA 70, Article 645 Information Technology Equipment
- h. ANSI/NFPA 70, Article 770– Optical Fiber Cables and Raceways
- i. ASTM A 510 Specifications for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
- j. ASTM B 633 Specifications for Electrodepositing Coatings of Zinc on Iron and Steel, Sections SC2 and SC3
- k. ASTM A653 Specifications for Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process
- 1. ASTM A123 Specifications for Zinc (Hot Galvanized) Coatings on Iron and Steel
- m. ICSI<sup>®</sup> Outside Plant Design Reference Manual (COOSP)
- n. BICSI<sup>®</sup> Electronic Safety and Security Reference Manual (ESSDRM)
- o. BICSI® Information Transport Systems Installation Methods Manual (ITSIM)
- p. BICSI® Network Design Reference Manual (NDRM)
- q. BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM)
- r. BICSI<sup>®</sup> Wireless Design Reference Manual (WDRM)
- s. Institute of Electrical and Electronic Engineers (IEEE)
- t. National Electrical Manufacturers Association (NEMA; generally)
- E. NEMA VE 2-2006 Cable Tray Installation Guidelines
- F. NEMA VE-1/CSA C22.2 No 126 1-02 Metal Cable Tray Systems
  - a. Underwriters Laboratories (UL<sup>®</sup>) Cable Certification and Follow up Program
- G. UL<sup>®</sup> E209183
  - a. American Standards Association (ASA)
- 1.7 RELATED SECTIONS
  - A. Section 01 0000 General Requirements
  - B. Section 02 0000 Existing Conditions
  - C. Section 27 0500 Common Work Results for Communications
  - D. Section 27 0505 Selective Demolition for Communications
  - E. Section 27 0513 Communications Services
  - F. Section 27 0526 Grounding and Bonding for Communications Systems
  - G. Section 27 0528 Pathways for Communications Systems
  - H. Section 27 0529 Hangers and Supports for Communications Systems
  - I. Section 27 0533 Conduits and Backboxes for Communications
  - J. Section 27 0553 Identification for Communication Systems

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- K. Section 27 0800 Commissioning of Communications
- L. Section 27 1100 Communications Equipment Room Fittings
- M. Section 27 1116 Communications Cabinets, Racks, Frames and Enclosures
- N. Section 27 1119 Communications Terminations Blocks and Patch Panels
- O. Section 27 1123 Communications Cable Management and Ladder Rack
- P. Section 27 1126 Communications Rack Mounted Power Protection and Power Strips
- Q. Section 27 1323 Communications Optical Fiber Backbone Cabling
- R. Section 27 1543 Communications Faceplates and Connectors
- S. Section 27 1619 Communications Patch Cords, Station Cords, and Cross Connect Wire
- 1.8 ABBREVIATIONS and ACRONYMS
  - A. AFF: Above Finished Floor
  - B. AWG: American Wire Gauge
  - C. BICSI<sup>®</sup>: Building Industry Consulting Services International
  - D. CAT6: Category 6 Copper Cable
  - E. CAT6A: Category 6A Copper Cable
  - F. CMGC: Construction Manager/General Contractor
  - G. CMP: Communications Multipurpose Plenum: cable rating
  - H. CMR: Communications Multipurpose Riser: cable rating
  - I. DWG/.DWG: AutoCAD file extension
  - J. HVAC: Heating, Ventilation, and Air Conditioning
  - K. IDF: Intermediate Distribution Frame
  - L. IMC: Intermediate Metal Conduit
  - M. Mbps: Megabits per second
  - N. MDF: Main Distribution Frame
  - O. OSHA: Occupational Safety and Health Act
  - P. OSP: Outside Plant
  - Q. RMC: Rigid Metal Conduit
  - R. SCS: Structured Cabling System
  - S. TIA: Telecommunications Industry Association
  - T. TR: Telecommunications Room
  - U. UL<sup>®</sup>: Underwriters Laboratory

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# V. WAO: Work Area Outlet

## 1.9 DEFINITIONS

- A. Bonding: The joining of metallic parts to form an electrically conductive path.
- B. Common Bonding Network (CBN): The set of metallic components that are interconnected to form the principle means for effectively bonding equipment inside a building to the grounding electrode system.
- C. Conduit: A raceway of circular cross-section.
- D. Conveniently Accessible: Being capable of being reached from floor or use of 8' step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.
- E. EMT electrical metallic tubing.
- F. Equipment Room: An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect, as well as video surveillance and security equipment.
- G. Exothermic Weld: A method of permanently bonding two metals together by a controlled heat reaction resulting in a molecular bond.
- H. Ground: A conducting connection, whether intentional or incidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.
- I. Horizontal Cabling: Cabling used to connect individual work area outlets to local Floor Distributors (FD) or other collection points. Unlike backbone cabling, horizontal cabling does not typically carry aggregate traffic and, as such, impacts only single network devices or users. In buildings, horizontal cabling almost exclusively consists of copper cabling. Fiber optic cabling may be used where situations dictate but, unlike horizontal copper cabling, horizontal fiber optic cabling is not installed in advance as default building facilities.
- J. Intermediate Distribution Frame, also known as telecommunications closet
- K. Junction box a NEMA listed box wherein a conduit run transitions from a feeder conduit to multiple distribution conduits.
- L. Main Distribution Frame, also known as the Main Equipment Room.
- M. Owner: Corvallis School District.
- N. Owner's Representative: An entity assigned to represent the Owner in all matters pertaining to this project. Used synonymously with "Owner".

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- O. Plenum: A space within the building designed for the movement of environmental air; i.e., a space above a suspended ceiling or below an access floor.
- P. PMP: Project Management Professional, as certified by the Project Management Institute.
- Q. Point of Entrance (Building Entrance): The point within a building at which the OSP communications wire or cable emerges from an external wall, from a concrete floor slab, or from an RMC or an IMC connected by a grounding conductor to an electrode in accordance with the NEC<sup>®</sup>.
- R. Primary Bonding Busbar (PBB): A busbar placed in a convenient and accessible location and bonded, by means of the telecommunications bonding conductor (TBC), to the building service equipment (power) ground.
- S. Pull box a NEMA listed box with a removable cover, used to facilitate pulling cable through conduit runs longer than 100' or in which there are more than 180 degrees of bends.
- T. Raceway: Any channel designed for holding wires or cables; i.e. conduit, electrical metal tubing, busways, wireways, ventilated flexible cableway.
- U. RMC rigid metal conduit
- V. Secondary Bonding Busbar (SBB): A common point of connection for telecommunications system and equipment bonding to ground.
- W. Subcontractor, Telecommunications: Entity responsible for all telecommunications work in the construction documents (Drawings and specification Sections 27 0000 through 27 5319).
- X. Telecommunications: In general, telecommunications refers to infrastructure/equipment needed for the voice, data, and video communications and transport systems.
- Y. Telecommunications Bonding Backbone (TBB): A conductor that interconnects the primary bonding busbar (PBB) to the secondary bonding busbar (SBB).
- Z. Telecommunications Bonding Conductor (TBC): The conductor used to connect the grounding electrode to the equipment grounding conductor, to the grounded conductor, or both of the circuits at the service equipment, or at the source of a separately derived system.
- AA. Telecommunications Equipment Bonding Conductor (TEBC): A conductor that connects the primary bonding busbar (PBB) or secondary bonding busbar (SBB) to equipment racks or cabinets.
- BB. Telecommunications Room/Space: An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling. The Main Equipment Room may also be known as the ER or the MDF, and may be co-located with the building's Entrance Room and Equipment Room. Telecommunications Rooms will also house equipment for additional systems, such as security, cable television, and audio/video.

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CC. Voluntary alternatives: substitution requests for products substantially similar to those specified herein.

# 1.10 PROJECT DRAWINGS

- A. General Drawing Specifications: Detail and elevation Drawings shall be ARCH E size (30" x 42") with a minimum scale of 1/8" = 1'0" or larger. ER, TR and other enlarged detail floor plan Drawings shall be ARCH E size with a minimum scale of 1/4" = 1'0" or larger. Building composite floor plan Drawings shall be ARCH E size with a minimum scale of 1/8" = 1'0".
- B. Building composite floor plans: Provide building floor plans showing outlet locations and jack configuration, types of jacks, run distance for each jack cable, and cable routing/locations. Identify WAO's that, according to location and available pathway systems, require cable length greater than allowed by standards. Recommend alternatives for Owners Representative's consideration.
- C. Telecommunications space plans/elevations: Include enlarged floor plans of TRs indicating layout of equipment and devices, including receptacles and grounding provisions.

# 1.11 QUALITY ASSURANCE

- A. When articles, materials, operations or methods related to execution of communications work are noted, specified, or described in the specifications or are indicated or reasonably implied on Drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.
- B. The Drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Contractor shall install work complete and ready for the installation of telecommunications cabling, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the Drawings, and in conformity with the dimensions indicated on architectural Drawings and on shop Drawings approved by the Owner.
- C. The Drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility; they do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Contractor.
- D. The Drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

## 1.12 WARRANTY

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- A. Warranty Requirements: Comply with additional requirements in contract general requirements and extended warranties required in other specification sections. Refer to all other Division 27 sections for specific additional warranty requirements that exceed or are in addition to those of this section.
- B. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty.
- C. Project Warranty
  - 1. Equipment and materials required for installation under these specifications shall be the current model and new (less than one year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect.
  - 2. When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or Owner.
- D. Owner's rights: This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.

# 1.13 SUBSTITUTIONS

- A. Substitution requests: Substitution requests will be considered only if submitted to Owner's Representative not less than 7 working days prior to project bid date. Acceptance or rejection of proposed substitution is at Owner's Representatives sole discretion. No exceptions. Requests for substitutions shall be considered not approved unless approval is issued in writing by Owner's Representative.
- B. Rejection: For equipment, cabling, wiring, materials, and all other products indicated or specified as no substitutions or no alternates, Owner does not expect nor desire requests for substitutions and alternate products other than those specified. Owner reserves right for Owner's Representative to reject proposed substitution requests and submissions of alternates without review or justification.

# 1.14 SUBMITTALS

- A. General Requirements
  - 1. Owner is to review all submittals related to Division 27 work. This includes, but is not limited to, relevant:
    - a. Pre-bid questions.
    - b. Contractor and personnel qualifications with bid.
    - c. Voluntary alternates and unit pricings with bid.

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- d. Pre-construction product submittals and shop Drawings.
- e. Change order requests, requests for information (RFIs), design change directives (DCDs), and any other changes as directed by the architect/engineer.
- 2. Allow a minimum of one week (five working days) for the Owner to review.
- B. The following submittals are due at the Pre-Bid deadline for questions:
  - 1. Requests for product substitution shall be in accordance with this document.
  - 2. All products seeking approval either as "approved equivalent" or otherwise, shall be submitted as a product substitution request prior to bid. Failure to submit product substitution request in a timely manner (before pre-bid questions are due) may preclude product from being utilized on the project. Requests made with bid or post-bid will not be considered without a significant cost savings realized to the Owner.
    - a. The burden of proof is on the contractor to provide documentation that equivalent product meets the specifications and project requirements. Include in substitution request:
      - 1) Product being replaced.
      - 2) Reason for product substitution.
      - 3) Full manufacturer specification sheet clearly indicating that all requirements in project documents have been met.
    - b. Failure to meet these requirements will result in the product substitution request being returned without review.
    - c. All product substitution requests are to be reviewed and approved by the Owner. Not all requests will be approved, and all decisions are final, without recourse.
- C. The following submittals are due with the Bid:
  - 1. Voluntary alternatives (that realize substantial cost savings), if any
  - 2. Unit pricing for the following items:
    - a. All unit pricing relating to Division 27 as identified in these documents and accompanying T series Drawings.
- D. The following submittals are due at the Pre-Construction Phase (to be delivered to the Owner):
  - 1. General Requirements:
    - a. Follow submission guidelines as outlined in this section.
      - 1) Strictly electronic submission to Owner is acceptable.
    - b. Ensure a cover page with Project Title, Telecommunication Subcontractor Company, and point of contact is included for all physical submittals.
  - 2. Product Information, divided by Specification Section and in order as listed in specification. Identify the start of each specification section.
    - a. Provide manufacturer's product information cutsheet or specifications sheet with the

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specific product number identified or filled out.

- 1) Submitted cutsheets without specific product identified will result in the whole submittal being returned without review.
- 2) No product substitutions will be considered post bid without a significant cost savings to the project to be realized by the owner a minimum of \$1000, either in material or labor savings. For any product substitution requests post-bid, Telecommunications Subcontractor shall submit an RFI through the proper channels with the requested documentation from the Pre-bid requirements above. Also, include realized cost savings. The project team may issue a change order (or its equivalent) for the product change at their discretion.
  - a) One exception to this is if the specified product goes out of production and is unavailable before submitted shop Drawings are approved. Telecommunications or Subcontractor is to submit an RFI explaining the situation and recommending an equivalent product with the same features at no cost change to the project or Owner.
  - b) Other exceptions may be considered. Telecommunications Subcontractor is to submit an RFI explaining the situation.
- 3. Shop Drawings
  - a. Generate electronic shop drawings in AutoCAD® .DWG file format, version 2019 (or newer); saved to DVD, USB flash drive, or project web site. File names should clearly identify the project name and number. Shop Drawings shall include Telecommunications or Subcontractor title block, and readily printable Plot/Drawing tabs with mview-window at a scale to not be less than 1/8" = 1'-0" unless otherwise noted. The scale shall also be indicated on the drawings.
  - b. Acceptable electronic shop drawing sizes include:
    - 1) 8.5"x11"
    - 2) 11"x17"
    - 3) 30"x42"
  - c. Refer to individual sections for additional requirements.
  - d. Communications pathways.
    - 1) Hangers and Supports indicate proposed routing of all cabling supported by J-hooks.
    - 2) Firestopping indicate manufacturer, product/assembly, and UL system for all firestop penetrations required for communications cabling.
- E. The following submittals are due during Construction (project closeout), in accordance with the requirements of this Section 270000 Communications:
  - 1. 3 weeks prior to Substantial Completion:
    - a. Record Drawings.
      - 1) Modify reviewed and accepted AutoCAD® shop Drawings to include

## COMMUNICATIONS

#### 27 0000 - 11

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revisions based upon completion of work.

- Provide one printed set of record Drawings to scale (not less than 1/8" = 1'-0").
- 3) This set is to include system function diagrams and details not on original construction documents.
- b. With the exception of the (1) printed set of record Drawings, submit these files electronically on DVD, USB flash drive, or project web site. File names should clearly identify the project name and number.

# 1.15 ADDITIONAL REQUIREMENTS

- A. Integration: Responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and suppliers shall rest with Contractor named in this contract. Work covered by this division of specifications shall be coordinated with related work indicated on Drawings or specified elsewhere under project specifications. All work related to telecommunications system and required for complete and operational systems as detailed in these specifications or the accompanying T series Drawings shall be performed under direct supervision of telecommunications installer in a manner approved by product manufacturer.
- B. Coordination of work: Contractor shall be responsible for coordination of work among project specification divisions and contractor/subcontractors involved in this project. This coordination of work includes following instructions provided throughout all Division 27 specifications and the accompanying T series Drawings as well as electrical work (Division 26) as called out in the narrative portions of Division 27 or so referenced in the accompanying T series Drawings.
- C. General compliance requirements: Provide a complete and operable system in compliance with project Drawings, specifications, referenced standards, applicable building codes, and Authority Having Jurisdiction (AHJ) requirements. Scope of this contract includes planning, design, materials, equipment, labor, configuration, programming, testing, startup and commissioning services, and documentation costs for complete and operable system that meets all requirements indicated on Drawings or contained in specifications. Comply with all contract documents, specifications, Drawings, manufacturer's instructions, and Owner and AHJ requirements. In case of conflict among applicable documents or standards, contractor shall notify owner's representative in writing of apparent conflict, and then comply with most stringent requirements unless otherwise directed in writing from owner's representative.

# 1.16 DELIVERY STORAGE AND HANDLING

A. General: Owner will, at Contractor's request, provide appropriate space on site for Contractor trailer or job box; however, Contractor shall be responsible for the deliveries, storing and handling of all materials that are part of the contract. Material shall be stored and protected according to manufacturer's instructions. Contractor shall be responsible for the security of all material during installation. For all material provided by contractor, or delivered to contractor on site, contractor assumes full responsibility and liability for any material shortages, damage or loss due to storage and handling methods.

## COMMUNICATIONS

## 1.17 PERMITS AND INSPECTIONS

- A. General: All telecommunications systems shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over the telecommunications systems and the Project.
- B. Contractor shall obtain and pay for all licenses, permits, and inspection fees required by local agencies and/or other agencies having jurisdiction. Copies of all permits shall be delivered electronically to the Owner.
- C. Contractor agrees to furnish any additional labor or material required to comply with all local and other agencies having jurisdiction at no additional cost.
- D. Contractor shall obtain certificates of inspection and approval from all authorities having jurisdiction, and forward copies of same to Owner prior to request for Project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing/demonstrations.
- E. All required permits and inspection certificates shall be made available at the completion of the telecommunications system installation and commissioning.
- F. Any portion of the telecommunications work which is not subject to the requirements of an electric code published by a specific AHJ shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association (NFPA).
- G. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).
- H. All work shall comply with the most current version of the TIA Standards listed in this document.

# 1.18 EXAMINATION

- A. General: Prior to submitting a proposal, Contractor shall examine site, review Project Drawings and specifications, and determine exact extent of work required. Contractor shall include in their proposals all materials, labor, and equipment required to complete required work indicated. Work that is necessary to obtain complete and usable Project as specified herein shall be included in Contractor's proposal, even if not indicated or specified.
- B. Bidders' questions: Should bidders have questions as to intent of Drawings and specifications, quality of materials to be used, and work to be performed, questions shall be submitted in writing to the Owner as dictated by the Owner at the pre-bid conference. All answers and clarifications to Drawings and specifications will be issued in writing.

## 1.19 ADDITIONAL COSTS

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- A. General: Project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing/demonstrations shall be conducted after verification of system operation and completeness by Contractor.
- B. Inspections and testing: For Project acceptance inspections, final completion inspections, substantial completion inspections, and/or testing/demonstrations that require more than one site visit by Owner or Architect/Engineer to verify Project compliance for same material or equipment, Owner reserves right to obtain compensation from Contractor to defray cost of additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions. Owner will notify Contractor of hourly rates and travel expenses for additional site visits, and will issue an invoice to Contractor for additional site visits. Payment of additional site visit costs by Contractor is required within 30 days of invoicing. Owner reserves right to deduct additional costs defined herein that are indicated on past due invoices from Project amount due Contractor.
- C. Exclusions: Contractor shall not be eligible for extensions of Project schedule or additional charges resulting from additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions. Extra payment will not be allowed for claims due to unfamiliarity with work to be performed by other trades, existing conditions at job site, local or state laws and codes, and alterations due to field conditions.

# 1.20 PROJECT CONTACT INFORMATION

- A. Owner's Consultants: Owner has retained the following design and project management professionals who have prepared designated portions of the Contract Documents:
  - 1. Communications: NIS 4900 SW Griffith Drive #250 Beaverton OR 97005 Phone: 503.246.8585 E-Mail: pmp@nis.consulting

# PART 2 - PRODUCTS

# 2.1 REFERENCE BRANDS AND PART NUMBERS – BASIS OF DESIGN

- A. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.
- B. Reference brands and part numbers listed within Division 27 represent the Basis-of-Design and are as required by the Owner. Alternates may be proposed but shall meet or exceed specifications for the items listed. Acceptance shall be at the Owner's sole discretion.

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- C. Bidder shall confirm all reference part numbers, listed within Division 27, as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies prior to bidding.
- D. Prior to submitting bids, the Contractor shall call to the attention of the Owner any materials or apparatus that the bidder believes to be inadequate and to any necessary items of work omitted.
- E. All materials associated with reference parts shall be included so as to constitute a complete and functional system, whether or not specifically identified, itemized, and quantified

# PART 3 - EXECUTION

# 3.1 GENERAL

- A. Coordinate with all other trades prior to installation.
  - 1. Contractor shall meet with Mechanical, and General Contractors prior to construction to identify pathway and infrastructure space requirements.
    - a. At a minimum, the following items shall be discussed:
      - 1) Placement for sleeving and wall penetrations.
      - 2) Failure to coordinate sufficient space for telecommunications infrastructure shall result in relocation of various systems by the contractor at no additional cost to owner.
  - 2. Prior to the start of work, the Telecommunications Subcontractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where Division 27 work may properly commence. Start of work indicates acceptance of conditions.
  - 3. Coordinate location of equipment and conduit with other trades to minimize interference.
    - a. Holes through concrete and masonry structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building.
    - b. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the General Contractor as required by limited working space.
    - c. Holes shall be located so as not to affect structural sections such as ribs or beams.
    - d. Holes shall be laid out in advance. The General Contractor shall be advised prior to drilling through structural sections, for determination of proper layout.
    - e. Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.
- B. Follow all manufacturers' instructions and install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.

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- 1. In the event of discrepancy, immediately notify the Owner through the proper channels. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.
- C. Protection of Systems and Equipment
  - 1. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
  - 2. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.
  - 3. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
- D. As determined by the Owner, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner shall be final.
- E. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.
- F. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.
- G. Access to Equipment
  - 1. Equipment shall be installed as per the scaled detail on the Electrical (E- series) and Telecommunications (T-Series) Drawings.
  - 2. Working spaces shall be not less than specified in the National Electrical Code® for voltages specified.
  - 3. Where the Owner determines that the Contractor has installed equipment not "conveniently accessible" for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Owner, at no additional cost to the Owner.
- H. Cleaning
  - 1. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.
  - 2. Remove dust and debris from interiors and exteriors of telecommunications equipment (including electrical rough-in). Clean accessible current carrying elements prior to being energized.
- I. Completion
  - 1. General:
    - a. Upon completion of the work, remove excess debris, materials, equipment,

# COMMUNICATIONS

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apparatus, tools and similar items. Leave the premises clean, neat and orderly.

- 2. Results Expected:
  - a. Systems shall be complete and operational.
  - b. Cleaning work shall be complete.
- 3. Commissioning
  - a. At a minimum, the Owner shall check the following items:
    - 1) J-Hook size, location, and clearance.
    - 2) Location and size of communications conduits or pathways.
    - 3) That power receptacles within the communications rooms meet the design requirements.
    - 4) The Owner is then to issue a written report to the General Contractor identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed.
    - 5) This report is not necessarily all inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.

END OF SECTION 27 0000

## COMMUNICATIONS

27 0000 - 17

# SECTION 27 0500 - COMMON WORK RESULTS FOR COMMUNICATIONS

# PART 1 - GENERAL

# 1.1 SECTION INCLUDES

- A. General Requirements
- B. Summary
- C. Environmental Considerations
- D. Site Specific Requirements
- E. Device Locations
- F. Project Contact Information

## 1.2 RELATED SECTIONS

A. See Section 270000 Part 1.7 for full information.

## 1.3 GENERAL REQUIREMENTS

- A. Corvallis School District is a tobacco free environment. Tobacco in any form whatsoever is not permitted in this school or on the property owned by the District.
- B. Corvallis School District is performing work as per the accompanying drawings. This contract will be responsible for all aspects of telecommunications cabling and supporting infrastructure required for functional systems, specifically:
  - 1. All construction in the Telecommunications Rooms.
  - 2. Pathways as per Section 27 0528 and as called out on drawings.
  - 3. Installation of horizontal cabling system and related components as per Sections 27 1513 and 27 1543.
  - 4. Installation of fiber optic backbone as per Section 27 1323.
  - 5. Testing of fiber and copper cabling systems in accordance with ANSI/TIA-568 and as per Section 27 0800.
  - 6. Creation of as-built documentation, both electronically and printed, in AutoCAD® (2019 or newer) format. Drawing base(s) will be provided electronically in .DWG format.
  - 7. Installation of Wireless Access Points as per Section 27 2133
  - 8. Installation of paging, intercom and bell system as per Section 27 5113.

# 1.4 SUMMARY

# COMMON WORK RESULTS FOR COMMUNICATIONS

27 0500 - 1

- A. The intent of the Division 27 Specifications and the accompanying Drawings are to provide complete telecommunications systems, including pathways and a bonding and grounding system as specified and required by applicable codes and the Authority Having Jurisdiction (AHJ). The Division 27 specifications include all work as specified in and shown on the accompanying Drawings, including appurtenances, to provide complete and functional systems
- B. The Division 27 Specifications and accompanying Drawings are complementary and what is called for in one shall be as binding as if called for in both. Items shown on the Drawings are not necessarily included in or called out in the Specifications and vice versa. Specifications shall supersede Drawings in the case of a conflict.
- C. Imperative language is frequently used in the Division 27 Specifications. Except as otherwise noted, such requirements are to be performed by the Contractor or a Sub-contractor directly responsible to the Prime Contractor performing the Division 27 work.
- D. The Drawings accompanying Division 27 are diagrammatic. They do not show every component of a complete premises distribution system which may be required to accommodate unique building construction features or materials installed by other trades. The Drawings are to be followed as closely as practical while making necessary adjustments in the placement of cable to facilitate the overall construction of the building without additional cost to the Owner. The right is reserved to make any reasonable changes in Work Area Outlet locations prior to roughing-in.

# 1.5 ENVIRONMENTAL CONSIDERATION

- A. When at all possible, equipment and materials are to be assembled at Distributors or Contractors location and delivered to construction site without packaging or shipping material.
- B. Except as noted for purposes of recycling, all construction related debris; packaging and waste materials will be removed from the job site each day and disposed of by the Contractor.

# 1.6 SITE SPECIFIC REQUIREMENTS

- A. Contractor must conform to schedule prescribed by General Contractor.
- B. Site details are shown on the accompanying drawings.

# 1.7 DEVICE LOCATIONS

- A. Telecommunication Room location as per the Drawings.
- B. Cabling, pathway, fire stopping, and support structures as per the Drawings and specifications.

# 1.8 PROJECT CONTACT INFORMATION

# COMMON WORK RESULTS FOR COMMUNICATIONS

27 0500 - 2

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- A. Owner's Consultants: Owner has retained the following design and project management professionals who have prepared designated portions of the Contract Documents:
  - 1. Communications: NIS 4900 SW Griffith Drive #250 Beaverton OR 97005 Phone: 503.246.8585 E-Mail: pmp@nis.consulting

PART 2 - (NOT USED)

PART 3 - (NOT USED)

END OF SECTION 27 0500

# COMMON WORK RESULTS FOR COMMUNICATIONS

27 0500 - 3

# SECTION 27 0505 - SELECTIVE DEMOLITION FOR COMMUNICATIONS

# PART 1 - GENERAL

# 1.1 SECTION INCLUDES

- A. General Requirements
- B. Summary
- C. Environmental Considerations
- D. Site Specific Requirements
- E. Device Locations
- F. Project Contact Information

# 1.2 RELATED SECTIONS

A. See Section 27 0000 Part 1.7 for full information.

# 1.3 GENERAL REQUIREMENTS

- A. Perform selective demo of existing systems as per the accompanying drawings. This contract will be responsible for aspects of telecommunications cabling and supporting infrastructure required for functional systems, specifically:
  - 1. All construction in the Telecommunications Rooms.
  - 2. Installation of single-mode fiber optic backbone as per Section 27 1323.
  - 3. Removal of existing fiber optic backbone and other components being replaced as part of this contract.

# 1.4 SUMMARY

- A. The Division 27 Specifications and accompanying Drawings are complementary and what is called for in one shall be as binding as if called for in both. Items shown on the Drawings are not necessarily included in or called out in the Specifications and vice versa. Specifications shall supersede Drawings in the case of a conflict.
- B. Except as otherwise noted, such requirements are to be performed by the Contractor or a Subcontractor directly responsible to the Prime Contractor performing the Division 27 work.
- C. The Drawings accompanying Division 27 are diagrammatic. They do not show every component

# SELECTIVE DEMOLITION FOR COMMUNICATIONS

27 0505 - 1

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of a complete premises distribution system which may be required to accommodate unique building construction features or materials installed by other trades. The Drawings are to be followed as closely as practical while making necessary adjustments in the placement of cable to facilitate the overall construction of the building without additional cost to the Owner. The right is reserved to make any reasonable changes in Work Area Outlet locations prior to roughing-in.

- D. Existing racks and cabinets and racks will be repositioned as called out in the drawings.
- E. Where being replaced, existing cabling shall be demolished to its origination point and recycled by the contractor.

# 1.5 ENVIRONMENTAL CONSIDERATION

A. Except as noted for purposes of recycling, all construction related debris; packaging and waste materials will be removed from the job site each day and disposed of by the Contractor.

## 1.6 SITE SPECIFIC REQUIREMENTS

- A. Contractor must conform to schedule prescribed by General Contractor.
- B. Site details are shown on the accompanying drawings.

## 1.7 DEVICE LOCATIONS

- A. Telecommunication Room location as per the Drawings.
- B. Cabling, pathway, fire stopping, and support structures as per the Drawings and specifications.

# 1.8 PROJECT CONTACT INFORMATION

- A. Owner's Consultants: Owner has retained the following design and project management professionals who have prepared designated portions of the Contract Documents:
  - 1. Communications: NIS 4900 SW Griffith Drive #250 Beaverton OR 97005 Phone: 503.246.8585 E-Mail: pmp@nis.consulting

PART 2 - (NOT USED)

# PART 3 - (NOT USED)

# SELECTIVE DEMOLITION FOR COMMUNICATIONS

27 0505 - 2
# END OF SECTION 27 0505

# SELECTIVE DEMOLITION FOR COMMUNICATIONS

27 0505 - 3

# SECTION 27 0513 – COMMUNICATIONS SERVICES

# PART 1 - GENERAL REQUIREMENT

# 1.1 SECTION INCLUDES

- A. Basic Communication Requirements
- B. Administrative Requirements
  - 1. Contract Documents, Quality Assurance, and Manufacturer's Warranty
  - 2. Technical Qualifications
  - 3. Certificates and Reference Standards
  - 4. Laws and Regulations, Permits
  - 5. Submittal and Substitution Information
  - 6. Environmental Requirements
  - 7. Progress Drawings and Schedules

### 1.2 RELATED SECTIONS

A. See Section 27 0000 Part 1.7 for full information.

# 1.3 BASIC COMMUNICATION REQUIREMENTS

- A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture.
- B. The Contractor shall field-investigate this facility to ascertain the exact physical and electrical conditions in the Main Equipment Room (ER or MDF), and the Telecommunications Rooms (TR) locations to become familiar with the physical environment of the building.
- C. The Contractor shall provide, install, and test the entire cable infrastructure as described under this contract.
- D. The Contractor shall call attention to the Owner any error, conflict, or discrepancy in Plans and/or Specifications. Do not proceed with any questionable items of work until a resolution or clarification has been made. Supplemental Plans and Specifications may be supplied as required and shall become part of the Contract Documents.

# 1.4 CONTRACT DOCUMENTS

A. The contract documents, such as drawings, schedules and specifications are used to describe the required work.

#### COMMUNICATIONS SERVICES

#### 27 0513 - 1

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- B. The work to be performed under the contract documents includes furnishing all labor, materials, equipment and services necessary, whether listed in the specifications or not, to construct and install the complete communications infrastructure as shown on contract drawings and specifications.
- C. The drawings and schedules depict, in general, application-dependent data while the narrative/specifications, in general, define broader requirements, such as overall quality.
- D. The Contractor shall follow all specifications herein. In case of conflict between drawings and specifications, the latter shall prevail unless authorized in writing by the Owner.
- E. Supplementary Details and Plans may be supplied as required. They shall be issued as addendum and shall become a part of the Contract Documents.

# 1.5 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the owner or the owner representative.
- C. Strictly adhere to all Telecommunications Industry Association (TIA) and BICSI<sup>®</sup> recommended installation practices and manufacturer's guidelines when installing communications components.

# 1.6 MANUFACTURER'S WARRANTY CERTIFICATION

A. The manufacturer's certification must be supported by Contractor's successful completion of an installation class recognized by an independent organization (such as BICSI<sup>®</sup> or an accredited school). A written test is strongly preferred.

# 1.7 TECHNICAL QUALIFICATIONS

- A. Contractor must be certified by manufacturer as able to provide a 20-year (minimum) manufacturer's warranty certificate.
- B. A minimum of three references demonstrating Contractor's past installation experience in Certified single-mode fiber optics systems in similar facilities with a minimum of 50 nodes shall be submitted. The Contractor must supply a one-year warranty upon completion of the job.

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- C. At least 50% of the technicians, to include all on-site Journeymen Electricians, must have successfully completed the manufacturer's warranty certification class.
- D. All Journeymen are to possess a current Oregon License.
- E. All Apprentices are to be actively enrolled in an Oregon State approved electrical apprenticeship program.
- F. All Equipment/Telecommunication Room equipment shall be installed and tested on-site by a technician(s) who, by virtue of an acceptable training course or documented experience, is qualified to perform these procedures. Acceptable training may include successful completion of the manufacturer's training course, documented on-the-job experience or successful completion of applicable technical courses in a recognized trade school.
- G. Verification of the above requirements must be submitted in writing with bid.

#### 1.8 CERTIFICATES

- A. Contractor must provide evidence of ability to provide a Manufacturer's Certificate of Warranty for the system bid.
- B. Contractor must provide Technician Certificate(s) for the certified 50% mentioned in section item 1.7.B above.

### 1.9 REFERENCE STANDARDS

- A. The following standards:
  - 1. American National Standards Institute (ANSI).
  - 2. National Electrical Manufacturers Association (NEMA).
  - 3. Telecommunications Industry Association (TIA), specifically:
    - a. TIA TSB-125, Guidelines for Maintaining Optical Fiber Polarity through Reverse-Pair Positioning
    - b. TIA TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
    - c. TIA-526-7, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7
    - d. ANSI/TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises
    - e. ANSI/TIA-568.1-D, Commercial Building Telecommunications Infrastructure Standard
    - f. ANSI/TIA-568.2-D, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
    - g. ANSI/TIA-568.3-D, Optical Fiber Cabling and Components Standard
    - h. ANSI/TIA-569-D-2015, Telecommunications Pathways and Spaces
    - i. ANSI/TIA/607-D, Commercial Building Grounding (Earthing) and Bonding

# COMMUNICATIONS SERVICES

#### 27 0513 - 3

Requirements for Telecommunications.

### 1.10 LAWS AND REGULATIONS

- A. The latest versions, including addenda, as enforced by the local authority having jurisdiction of the following codes, associations, acts and agencies:
  - 1. Federal Communications Commission (FCC)
  - 2. National Fire Protection Association (NFPA), specifically:
    - a. NFPA 70, National Electrical Code<sup>®</sup> (NEC<sup>®</sup>) plus all Oregon State Electrical Code plus local County and City Amendments
    - b. NFPA 72, National Fire Alarm Code<sup>®</sup>
    - c. NFPA 76, Recommended Practice for the Fire Protection of Telecommunications Facilities
    - d. NFPA 101, Life Safety Code®
    - e. NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
    - f. NFPA 780, Standard for the Installation of Lightning Protection Systems
    - g. NFPA 5000<sup>TM</sup>, Building Construction and Safety Code
  - 3. National Electrical Safety Code<sup>®</sup> (NESC<sup>®</sup>)
  - 4. Occupational Safety and Health Administration (OSHA)
  - 5. 2018 Oregon Fire Code (OFC)

# 1.11 UNDERWRITERS LABORATORIES LISTING

A. Unless otherwise specified, electrical equipment and material shall be listed and labeled by Underwriters Laboratories (UL<sup>®</sup>) for the purpose for which it is used. This requirement may be waived only if a UL<sup>®</sup> listing is not available for this type of product. Telecommunications cables are acceptable if UL<sup>®</sup> recognized.

# 1.12 ADDITIONAL REFERENCE MATERIALS

- A. ANSI/NECA/BICSI-568-2006, Standard, Installing Commercial Building Telecommunications Cabling
- B. BICSI<sup>®</sup> Outside Plant Design Reference Manual (COOSP)
- C. BICSI<sup>®</sup> Electronic Safety and Security Reference Manual (ESSDRM)
- D. BICSI<sup>®</sup> Information Transport Systems Installation Methods Manual (ITSIM)

#### COMMUNICATIONS SERVICES

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- E. BICSI<sup>®</sup> Network Design Reference Manual (NDRM)
- F. BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM)
- G. BICSI<sup>®</sup> Wireless Design Reference Manual (WDRM)
- H. Institute of Electrical and Electronic Engineers (IEEE)
- I. National Electrical Manufacturers Association (NEMA)

# 1.13 PERMITS, LICENSES AND TAXES

A. Contractor shall obtain and pay for permits, inspections, licenses and taxes applicable to this work. Copies of all permits and inspections are to be prominently displayed at each site. Copies of all inspection reports are to be presented to Owner upon closeout of project.

# 1.14 SUBMITTALS

### A. PRODUCT DATA

1. Product Data submittal shall only be required if the Contractor requests a substitution or a brand product is not specified or recommended.

### B. PROCEDURES

- 1. Provide submittals to PIVOT Architecture.
- 2. Submit one electronic copy of all submittals.
- 3. If samples are requested, provide three samples to PIVOT Architecture
- 4. Owner must approve all submittals before the start of fabrication (or shipment, for stock items) of any equipment requiring submittals.

### C. DRAWINGS

- 1. The Contractor shall submit shop drawings for any modification or new product installation not previously identified in bid documents.
- 2. The drawing must be submitted not less than five (5) days (weekends and national holidays excluded) before the scheduled work begins.
- 3. The Contractor shall proceed with the installation only after approval from the Owner.

# D. MATERIALS LIST

1. The Contractor shall submit a list of all materials for the proposed work.

### E. FIRESTOPPING

1. The Contractor shall comply with all requirements of Section 07 8413 – Penetration Fire

# COMMUNICATIONS SERVICES

#### 27 0513 - 5

### Stopping

#### F. SOUND DEADENING MATERIALS

1. The Contractor shall submit a list of acoustic separation products and procedures. The submittal shall include the manufacturer's technical data for each product including product description, specifications (including labeling or listing by an agency acceptable to the Owner).

### G. MATERIAL SAFETY DATA SHEETS

1. Supply Material Safety Data Sheets (MSDS) to Owner for all material accompanied by such.

### H. TEST PLANS

- 1. The Contractor shall submit a plan for the testing the installed network.
- 2. The test plan shall include test equipment to be used, procedure and report structure.

# I. CERTIFICATES

- 1. Low Voltage Electrical Permit.
- 2. The Contractor shall post a copy of the permit and email or fax a copy to the Owner.
- 3. The Contractor shall provide copy of approved permit to the Owner certifying that the work has been inspected and that the work conforms to the requirements of the Authority Having Jurisdiction.

### J. PRODUCT WARRANTY

1. A manufacturer's warranty is required for this work in addition; Contractor shall provide no-cost warranty on the installed work for a period of one year.

### 1.15 REQUESTS FOR SUBSTITUTION

- A. Substitution of items shown in the contract documents must be requested in writing.
- B. Approval shall be by written addendum or change order. Substitutions made without prior written approval will be reversed and all costs related to reversal will be the responsibility of the Contractor.
- C. Contractor shall be responsible for any design changes and costs related to substitution approval.
- D. The functions and features specified are vital to the operation of these facilities; therefore the acceptance of alternate manufacturers does not release Contractor from strict compliance with the requirements of the specification.

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### 1.16 ENVIRONMENTAL REQUIREMENTS

- A. Power and lighting, and parking spaces for standard installer's trucks shall be provided by the General Contractor.
- B. Job site trailer, if required, shall be coordinated with the General Contractor prior to placement. Secured storage is the responsibility of the Contractor. See 27 0000 Part 1.16A DELIVERY STORAGE AND HANDLING for full information.

# 1.17 PROGRESS DRAWINGS AND SCHEDULES

- A. All drawings shall be revised as necessary during the course of the work.
- B. The Contractor shall maintain on-site, one neatly and legibly marked (redlined) set of full-size Drawings accurately depicting as-built locations, changes, and repairs made during the work.
  - 1. Marking of the Drawings shall be kept current.
  - 2. Drawings shall be delivered to the Owner prior to final progress payments.

### PART 2 - PRODUCTS

- 2.1 GENERAL
  - A. The use of a manufacturer's name and model or catalog number herein is for the purpose of establishing the product set, which the Contractor is to supply and install.
  - B. Quantities are to be determined by Contractor unless specified.
  - C. Products shall be UL<sup>®</sup> listed for the purpose they are to be used.

# 2.2 PRE-APPROVED PRODUCT SETS

A. The product sets listed within the Division 27 specifications are a basis of design and should be considered pre-approved. The District will not consider product sets that have not been pre-approved or accepted as per the substitution request process.

#### 2.3 FIRESTOPPING

- A. Comply with the requirements of Section 07 8413
- B. Products may be in the form of caulk, putty, strip, sheet, or devices that shall be specifically designed to fill holes, spaces, and voids at communications penetrations.
- C. Firestopping materials shall also provide adhesion to substrates and maintain fire and smoke seal

#### COMMUNICATIONS SERVICES

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under normal expected movements of substrates, conduits and cables.

### 2.4 ACOUSTIC SEPARATION

- A. Acceptable products for 2" through 4" penetrations are as follows:
  - 1. STI EasyPath<sup>™</sup>
  - 2. Resilient latex caulk and re-enterable putty manufactured by 3M<sup>™</sup>, Specified Technologies or Hilti
  - 3. Or approved substitution
- B. Acceptable products for less than 2" penetrations are as follows:
  - 1. Resilient latex caulk and re-enterable putty manufactured by 3M<sup>TM</sup>, Specified Technologies or Hilti
  - 2. Or approved substitution

### PART 3 - EXECUTION

### 3.1 GENERAL

- A. Manufacturer's installation instructions and requirements shall be strictly adhered to in the telecommunications equipment installation, fabrication and testing process.
- B. Where conflicts arise between the requirements of this Specification and the manufacturer's installation instructions, the Owner shall be consulted for resolution.
- C. All twisted pair wiring systems shall be installed according to manufacturers' installation guidelines, and according to related ANSI/TIA-568 standards.
- D. All installed cables shall be kept free from nicking, abrading, or cutting during storage and during the installation process.
- E. Cable shall be installed into conduits after conduit installation is complete and appropriate bushings or couplers have been installed. Manufacturers' recommendations for maximum pulling tensions and minimum bend radii for all cables must not be exceeded.
- F. Care shall be exercised in wiring to avoid damage to wiring and equipment.
- G. Connections shall be made with approved mechanical connectors.
- H. All wiring and connectors shall be installed in strict adherence to standard communications installation practices and to federal, state or local applicable codes.
- I. Equipment shall be firmly held in place. Fastenings, supports, and hangers shall be adequate to

#### COMMUNICATIONS SERVICES

#### 27 0513 - 8

support their loads.

- J. Open areas requiring suspension for cables will employ properly rated support mechanisms and devices to accommodate future addition of cable.
- K. Cable ties will be used in concealed areas only as mandated by code or ANSI/TIA-568. Cable ties shall bear the same rating as the cable when installed in plenum areas.
- L. Cable running in exposed areas will be bundled using Velcro<sup>®</sup> or similar hook and loop material. Such material will be used exclusively in the ER and TR. Cable ties are permitted for temporary cable dressing only and shall be removed prior to substantial completion.
- M. The installation must conform to OSHA standards and comply with state and local safety codes.
- N. Applicable fire codes will be strictly adhered to in regards to plenum ratings for cable and associated cable ties. Fire stopping will be the responsibility of this contract in areas penetrated as a part of this project.
- O. Installation shall be neat, well organized, and professional.
- P. Installation shall be conducted as to maintain consistency between color-coding, labeling and documentation.
- Q. Splicing of any fiber optic is not acceptable, unless directed to by specifications, addendum, drawings or other written communication with owner or authorized representative.
- R. Any discrepancies, conflicts or issues must be brought to the attention of the Owner before installation or as soon as possible thereafter.
- S. The Contractor shall clean up the work area at the end of each day. At the end of the project all material removed or left over, and/or not being used shall be removed from the project site unless other arrangements have been made. A final clean up shall be made before final payment is made.
- T. The Contractor shall coordinate with the General Contractor for final cleaning of the Equipment and all Telecommunications Rooms. Final cleaning shall include necessary steps to remove all debris from the rooms and provide completely dust-free surfaces on all installed components.
- U. All wall and floor penetrations shall be fire stopped at or before substantial completion.

# 3.2 PREPARATION

- A. Before installation of cabling and/or equipment in telecommunications spaces, the Contractor shall field-investigate the facility and ascertain if the physical and electrical conditions within the facility shall permit commencement of the Contractor's work.
- B. Any discrepancies, questions, or concerns noted at that time should be brought to the immediate attention of the Owner.

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### 3.3 DOCUMENTATION

### A. GENERAL

- 1. All hard copy documentation must be neat and legible.
- B. TEST REPORTS
  - 1. The Contractor shall compile test results into the forms that contain all applicable test data. Hard copy output indicating successful testing of every location is not required.
  - 2. A solid-state USB memory device containing all test data and the appropriate application to display such in a Windows-based environment shall be provided.
  - 3. Test results shall be in native format of the test equipment used and .PDF

#### 3.4 AS BUILTS

- A. Contractor will be provided the T series REVIT<sup>®</sup> or AutoCAD<sup>®</sup> drawings electronically. These drawings shall be the base drawings for the as built documentation with the following being provided by the Contractor as a separate REVIT<sup>®</sup> or AutoCAD<sup>®</sup> layer:
  - 1. Outlet location
  - 2. Cable routing and ID

### END OF SECTION 27 0513

# COMMUNICATIONS SERVICES

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### SECTION 27 0526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

### 1.1 SCOPE

- A. This section includes the requirements for establishing a telecommunications grounding and bonding system.
- B. Provide all labor, materials, tools, and equipment required for the complete installation of a telecommunications grounding system.
- C. Included in this section are the minimum composition requirements and installation methods for the following:
  - 1. Telecommunications grounding system
  - 2. Busbars
  - 3. Bonding accessories

### 1.2 REFERENCES

- A. References, Codes and Standards as required by Section 270000, Communications.
- B. ANSI/TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- C. UL 467 Standard for Grounding and Bonding Equipment.

#### 1.3 QUALITY ASSURANCE

- A. See Section 27 0513.
- B. All grounding and bonding cables shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- C. Grounding and bonding shall meet applicable ANSI/TIA-607-D, *NEC*<sup>®</sup> Articles 250 and 800 requirements and practices except where other authorities or codes may impose a more stringent requirement or practice.

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

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# PART 2 - PRODUCTS

### 2.1 PRIMARY BONDING BUSBAR

- A. PBB shall be constructed of 0.25" thick solid copper bar.
- B. The busbar shall be 4" high and 20" long and shall have 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
- C. The hole spacing pattern for attaching grounding lugs shall meet the requirements of ANSI/TIA/607-D and shall accept lugs with 5/8" with 1" centers.
- D. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
- E. The busbar shall be UL<sup>®</sup> Listed as grounding and bonding equipment.
- F. Manufacturer shall be:
  - 1. Harger
  - 2. Chatsworth (CPI)
  - 3. Or approved alternate

#### 2.2 SECONDARY BONDING BUSBAR

- A. SBB shall be constructed of 0.25" thick solid copper bar.
- B. The busbar shall be 2" high and 12" long and shall have 9 attachment points (one row) for twohole grounding lugs.
- C. The hole spacing pattern for attaching grounding lugs shall meet the requirements of ANSI/TIA/607-D and shall accept lugs with 5/8" and 1" centers.
- D. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" standoff from the wall.
- E. The busbar shall be UL<sup>®</sup> Listed as grounding and bonding equipment.
- F. Manufacturer shall be:
  - 1. Harger
  - 2. Chatsworth (CPI)
  - 3. Or approved alternate

### 2.3 BONDING ACCESSORIES

# GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

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- A. Two Mounting Hole Ground Terminal Block
  - 1. Ground terminal block shall be made of electroplated tin aluminum extrusion.
  - 2. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
  - 3. The conductors shall be held in place by two stainless steel set screws.
  - 4. Ground terminal block shall have two 0.25" holes spaced on 5/8" centers to allow secure two-bolt attachment to the rack or cabinet.
  - 5. Ground terminal block shall be UL<sup>®</sup> Listed as a wire connector.
- B. Compression Lugs
  - 1. Compression lugs shall be manufactured from electroplated tinned copper.
  - 2. Compression lugs shall have two holes spaced on 5/8" or 1" centers to allow secure two bolt connections to busbars.
  - 3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0.
  - 4. Compression lugs shall be UL<sup>®</sup> Listed as wire connectors.
- C. Antioxidant Joint Compound: Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

# PART 3 - EXECUTION

# 3.1 GENERAL

- A. A copper bonding and grounding system shall be installed which places a properly sized (as per Table 250-122 of National Electrical Code) copper cable in the immediate vicinity of the telecommunications backboard. Contractor shall be responsible for placement of the above referenced ground busbars and terminal(s) as well as their connection to the building system grounding cable using an exothermic-welded type connector or appropriate compression applied connector to satisfy the Authority Having Jurisdiction.
- B. Bonding and grounding shall meet applicable ANSI/TIA-607-D, *NEC*<sup>®</sup> Articles 250 and 800 requirements and practices except where other authorities or codes may impose a more stringent requirement or practice. All racks and cable trays shall be bonded to a ground busbar with #6 AWG cable. All termination equipment shall be bonded to a known source of building system ground according to the specifications of the manufacturer.
- C. Hard bends shall not be used on the bonding jumpers or wire, rather gradual bends with smooth radius.

# 3.2 BONDING AND GROUNDING SYSTEM USING STRUCTURAL METAL

A. When structural metal is bonded to the building's grounding electrode system it may be used in place of a TBB, a BBC or both. Before utilizing structural metal in place of a TBB or a BBC, building plans (including as-builts as applicable) and specifications shall be reviewed to ensure

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the structural metal is electrically continuous or can be made so. Additionally, the two point continuity test as described in ANSI/TIA-607-D paragraph 9.1, or equivalent, should be performed on the structural metal to verify electrical continuity and acceptable resistance along the paths used as bonding conductors. Concrete reinforcing steel shall not be used as a TBB or a BBC.

B. Connections to the PBB/SBB: The bonding conductor from the structural metal to the PBB or SBB shall be sized according to ANSI/TIA-607-D, Table 1. Additionally, this conductor should be no smaller than any conductor that comprises the telecommunications bonding backbone system. Bonds to structural metal shall be made using listed exothermic welding, listed compression, or listed mechanical connectors and shall be accessible. Bonds to the PBB or SBB shall be made as specified in ANSI/TIA-607-D, paragraphs 7.2.2 and 7.3.2, respectively.

# 3.3 PREPARATION

- A. Clean contacting surfaces of ground connections to bright metal before connecting.
- B. When making connection between dissimilar metals, i.e., copper to aluminum or galvanized structures, apply a corrosion-inhibitor such as Penetrox A to contact surfaces between connector, and surface of structure.

# 3.4 INSTALLATION

- A. All metallic components that make up the equipment racks and ladder rack shall be bonded together in a manner that provides continuous electrical continuity between the components. Attention must be given to the removal of paint of powder coating to present bare metal where bonding straps are fastened to the metallic component.
- B. Outdoor Grounding and Bonding Connections: All outdoor grounding and bonding (earthing) connections shall be accomplished using exothermic welding.
- C. Wall-Mount Busbars
  - 1. Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
  - 2. Conductor connections to the PBB or SBB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
  - 3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
  - 4. The wall-mount busbar shall be bonded to ground as part of the overall telecommunications bonding and grounding system.
- D. Ground Terminal Block
  - 1. Every rack and cabinet shall be bonded to the PBB or SBB.

# GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

- 2. Minimum bonding connection to racks and cabinets shall be made with a rack-mount twohole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
- 3. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.

END OF SECTION 27 0526

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

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# SECTION 27 0528 - PATHWAYS FOR COMMUNICATIONS

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.
- B. This section shall be performed by a qualified Contractor as outlined in the specifications.

### 1.2 DESCRIPTION OF WORK

- A. This contract shall be responsible for all pathways, cable trays, sleeves, hangers, and support mechanisms required to support all telecommunications cables and to satisfy the local AHJ.
- B. This contract shall be responsible for all pathways as called out on Drawings, specifically:
  - 1. Conduits and "J-Boxes" as detailed on Drawings to accommodate the fiber backbone. Any necessary penetrations shall accommodate a minimum of a Trade Size 1 EMT conduit.
  - 2. Any in-slab or under-slab conduits shall be a minimum of Trade size 1 <sup>1</sup>/<sub>4</sub> schedule 40 PVC.
- C. The Contractor shall coordinate with all other trades (if applicable) prior to final placement of telecommunications pathways. Placement shall be such that pathway will be accessible for future additions requiring placement of telecommunications cable.
- D. The Contractor shall provide all labor, equipment and supplies to furnish and install the communications pathway, hangers and supports.
- E. Installation shall include the actual physical installation of the hardware and/or support structure, firestopping and documentation.

#### 1.3 RELATED SECTIONS

A. See Section 27 0000 Part 1.7 for full information.

#### 1.4 QUALITY ASSURANCE

A. All components and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed.

#### PATHWAYS FOR COMMUNICATIONS

#### 27 0528 - 1

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B. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

### 1.5 SUBMITTALS

- A. The following information shall be provided:
  - 1. Manufacturer's literature and catalog cuts indicating:
    - a. Physical dimensions
    - b. Materials of construction

# PART 2 - PRODUCTS

### 2.1 GENERAL

A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture. Equipment and material shall carry Underwriters Laboratory certification if required by local, state or national codes. Products are to be from the acceptable manufacturer listed below or an approved alternate. In no case will field fabrication or "shop built" cable support products be acceptable.

### 2.2 ADJUSTABLE CABLE SUPPORT SYSTEM

- A. Cable support system shall be a factory produced assembly and sized to accommodate 100 percent expansion, i.e., rated to hold double the number of initially installed cables.
- B. Acceptable product is CADDY® CAT HP J-Hook

# 2.3 ROD MOUNTED CABLE SUPPORT SYSTEMS

A. Acceptable product is: CADDY<sup>®</sup> CAT-HP Cable Support System

#### 2.4 FIRE STOPPING SYSTEMS FOR TELECOM RACEWAYS

- A. Acceptable products for 2" through 4" penetrations are as follows
  - 1. STI EasyPath<sup>TM</sup>
  - 2. Resilient elastomeric caulk and re-enterable putty manufactured by 3M<sup>™</sup>, Specified Technologies or Hilti.
- B. Acceptable products for less than 2" penetrations are as follows

#### PATHWAYS FOR COMMUNICATIONS

#### 27 0528 - 2

1. Resilient elastomeric caulk and re-enterable putty manufactured by 3M<sup>TM</sup>, Specified Technologies or Hilti.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Install per manufacturer's instruction per weight loading.
- B. All conduits shall be installed stacked and attached to walls unless conditions exist which prohibit this type of installation. When this condition exists, mount conduits side-by-side supported with 3/8" rod attached to building structure utilizing UniStrut channel to form a trapeze. Double nut the top and bottom at the UniStrut Utilize conduit clamp to secure conduits to UniStrut.
- C. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/TIA-569,  $NEC^{\text{(B)}}$ , applicable local codes, and to the manufacturer's installation instructions.
- D. Do not exceed load ratings specified by manufacturer.
- E. Metal components shall be bonded and grounded in accordance with ANSI/TIA-607-D.
- F. Adjustable cable support systems are to be securely attached to building structure and loaded as per manufacturer's instruction.
- G. Fire Rated wall and floor penetrations shall be fire-stopped in accordance with the manufacturer's instructions using the product set referenced in 2.4 above.

END OF SECTION 27 0528

# PATHWAYS FOR COMMUNICATIONS

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# SECTION 27 0529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes discrete J-Hooks, slings and related accessories for supporting low voltage cable bundles above accessible ceilings.

### 1.2 REFERENCES

- A. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)
  - 1. ANSI/TIA-569-D Standard for Telecommunications Pathways and Spaces for Commercial Building
  - 2. ANSI/NFPA 70 National Electrical Code (NEC<sup>®</sup>)
- B. Underwriters Laboratories, Inc. (UL<sup>®</sup>)
  - 1. UL<sup>®</sup> 2043 Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
  - 2. UL<sup>®</sup> 2239 Conduit, Tubing and Cable Support Hardware

#### 1.3 RELATED SECTIONS

A. See Section 27 0000 Part 1.7 for full information.

# 1.4 DEFINITIONS

- A. Pathway A series of supports and accessories for placement of low voltage systems cables
- B. Main Pathway A low voltage systems pathway where the cable count exceeds 24 cables

# 1.5 SUBMITTALS

- A. Product Data: Submit product data on all cable support devices and accessories. Indicate materials, finishes, load ratings, dimensions, listings, approvals and attachment methods.
- B. Closeout Submittals
  - 1. As-built Drawings: Provide marked up as-built drawings of main pathways

#### HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

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### 1.6 QUALITY ASSURANCE

- A. Low voltage system cable supports and accessories shall be listed to Underwriters Laboratories, Inc. Standard 2239.
- B. Low voltage system cable supports and accessories shall have the manufacturers name and part number stamped on the part for identification.
- C. Pre-Installation Meetings: Contractor shall set up a pre-installation meeting to discuss low voltage cable support layout work and installation guidelines. Attendees shall include Owner contractor, and appropriate subcontractors. Purpose of meeting shall be to coordinate work between the parties to have a consistent layout for all low voltage system cables, minimize interferences and to make cable system accessibility for future Owner modifications and maintenance high priority issue for all installers.

### 1.7 COORDINATION

A. Coordinate layout and installation of low voltage cable bundle supports with other construction elements to ensure adequate headroom, working clearance and access. Revise locations and elevations for those indicated as required to suit field conditions and as approved by Owner.

# PART 2 - PRODUCTS

# 2.1 NON-CONTINUOUS CABLE SUPPORT SYSTEMS (J-HOOKS)

- A. Approved Manufacturers
  - 1. B-Line/Eaton
  - 2. nVent Caddy
  - 3. MonoSystems
- B. Shall be constructed of galvanized steel, stainless steel, or hot dipped zinc
- C. Fastener is to be installed using dedicated wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments. Product is to be UL® Listed for the application.
  - 1. Non-Continuous Cable Supports
    - a. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL® Listed.
    - b. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
    - c. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap

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shall be removable and reusable and be suitable for use in air handling spaces.

- 2. Adjustable non-continuous cable support sling
  - a. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 210 Cat6A UTP cables; rated for indoor use in non-corrosive environments. Rated to support Category 6 and higher cable, or optical fiber cable; UL<sup>®</sup> Listed.
  - b. Adjustable non-continuous cable support sling shall have a static load limit of not less than100 lbs.
  - c. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
  - d. If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.
- 3. Multi-tiered non-continuous cable support assemblies
  - a. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; UL<sup>®</sup> Listed.
  - b. If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
- 4. Non-continuous cable support assemblies from beam, flange
  - a. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL<sup>®</sup> Listed.
- 5. Non-continuous cable support assemblies from C & Z Purlin
  - a. Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, UL<sup>®</sup> Listed.
- 6. Non-continuous cable support assemblies from wall, concrete, or joist
  - a. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, UL<sup>®</sup> Listed.
- 7. Non-continuous cable support assemblies from threaded rod
  - a. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, UL<sup>®</sup> Listed.
  - b. The multi-tiered support bracket shall have a static load limit of 300 lbs.
  - c. U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts.

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- 8. Cantilever-Mounted cable supports
  - a. U-hook shall be able to be assembled to a wide variety of wall mount brackets.
  - b. Spacing of individual U-hooks as needed, max of 5' apart.
  - c. U-hooks may have the optional attachment of a cable roller for ease in pulling cables.

# PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. At no point shall J-Hook cable support assemblies be attached to "T-bar" or ceiling grid support wire.
- B. Cable installation and supports shall comply with applicable provisions of ANSI/TIA-569-D and ANSI/NFPA 70
- C. All low voltage systems cables shall be supported. Provide supports along entire pathway.
- D. Space supports a maximum of 60 inches apart and at each change of direction of the cables. In areas covered by dropped ceiling, tiles shall be left open to allow inspection by Owner.
- E. Hang cable supports from 3/8" all thread rods, dedicated #8 galvanized ceiling drop wire or wall brackets connected directly to structure. Do not support from the ceiling grid or ceiling wire system.
- F. Where main pathways are indicated on the Drawings, contractor shall follow the indicated pathways as closely as possible according to field conditions. Pathways for smaller cable counts shall be designed and documented on the as-built drawings by the contractor.
- G. Install support wires, brackets or rods to route cables parallel and perpendicular to building lines.
- H. Provide multiple hooks or slings at each hanger location as required by cable count and cable segregation requirements.
- I. Fill supports with cabling to 50% or less of the manufacturer's recommended fill. Provide multiple supports where required cable count exceeds 50% fill.
- J. Install low voltage cable support system above accessible ceilings only.
- K. Elevation of Cable Supports: Contractor shall coordinate the allocation of ceiling space and the mounting elevations to allow maintenance and accessibility for future modifications. Telecommunications cable supports shall be as close to the ceiling as possible while allowing ceiling tiles to be removed. Supports shall be located to avoid interference with maintenance access to other equipment.

#### HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

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END OF SECTION 27 0529

# HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

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# SECTION 27 0533 – CONDUITS AND BACKBOXES FOR COMMUNICATIONS

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

- A. Related Sections
  - 1. See Section 27 0000 Part 1.7 for full information.

### B. Other References

1. ANSI/TIA-569-D - Commercial Building Standard for Telecommunications Pathways and Spaces

### 1.2 DESCRIPTION

A. Provide raceway systems for the installation of the telecommunications cables. Installation shall include conduit, raceway, and sleeves for fiber backbone and IDF modifications.

### 1.3 REFERENCES

- A. Comply with the References requirements of Section 27 0000.
- B. In addition, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
  - 1. ANSI C80.1, American National Standard for Electrical Rigid Steel Conduit (ERSC)
  - 2. ANSI C80.3-2015, Electrical Metallic Tubing Steel (EMT-S)
  - 3. ANSI/NEMA FB-1-2012, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
  - 4. ANSI/NEMA OS 1, Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports
  - 5. NEMA 250-2014, Enclosures for Electrical Equipment

#### 1.4 SUBMITTALS

- A. General: Conform to Submittal requirements as described in Section 27 0000.
- B. Submittal Requirements at Start of Construction:
  - 1. Product Data Submittal
- C. Submittal Requirements at Close Out:

# CONDUITS AND BACKBOXES FOR COMMUNICATIONS

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- 1. Record Drawings Submittal
- D. Substitutions:
  - 1. As per requirements in Section 27 0000.
- 1.5 QUALITY ASSURANCE
  - A. Comply with Quality Assurance requirements of Section 27 0000.

### 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with Delivery, Storage and Handling requirements of Section 27 0000.

### 1.7 WARRANTY

A. Comply with Warranty requirements of Section 27 0000.

# PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Conduit: Minimum above slab and in-wall conduit size shall be Trade Size 1. Provide EMT conduit except as noted below:
  - 1. Under slab, and in floor: Provide schedule 40 PVC or RMC with external PVC coating. Protect male threads of RMC with PVC coating using an application of an electrically conductive two-part urethane coating. Minimum under slab or in slab conduit size shall be Trade size 1-½.
- B. Sleeves: Provide sleeves where required for wall and floor penetrations. Provide core drilling where required for sleeve installation. Sleeves shall be STI EZ® Path. Sizing shall be as noted on the Drawings.
- C. Firestopping: Provide firestopping material to maintain the fire rating of all penetrated walls, floors, and ceiling structures. Material shall be acceptable to the local fire and building authorities as well as applicable codes and shall be re enterable. STI EZ® Path sleeves satisfy this requirement

# 2.2 RIGID METAL CONDUIT (RMC) FITTINGS

A. RMC fittings shall be hot dipped galvanized or with a sherardized finish. Couplings shall be unsplit, NPT threaded steel cylinders with galvanizing equal to the conduit. Nipples shall be factory

#### CONDUITS AND BACKBOXES FOR COMMUNICATIONS

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made through eight inches in length. Running threads will not be allowed.

# 2.3 ELECTRICAL METALLIC TUBING (EMT) FITTINGS

A. Couplings and connectors shall be compression type employing a split, corrugated ring and tightening nut. They shall be steel. Cast metal or malleable iron will not be acceptable. Connectors shall be complete with integral insulated throat bushings, thread bushings and locknuts. Indent or set screw couplings and connectors are not acceptable.

### 2.4 CONDUIT SUPPORTS

- A. Conduit Clamps, Straps, and Supports: Steel.
- B. Support Channels
  - 1. Acceptable Manufacturers:
    - a. B-line
    - b. Kindorf
    - c. Unistrut®
    - d. Or approved equal
  - 2. 12 gauge galvanized or painted steel, "U" section, 1-½" square nominal in section.
  - 3. Hardware: Manufacturer's standard as required to support equipment. Supports and anchors shall be galvanized steel in dry areas; stainless steel in wet areas.
  - 4. Threaded Rod: Zinc plated steel, 3/8" diameter minimum, sized to support load

### 2.5 SEALANT

- A. Refer to Section 07 8413 Firestopping for approved manufacturers and requirements for firestopping systems and products. Products selected are to be based on tested UL<sup>®</sup> designs.
- B. Conduit sealant shall be clear or colorless RTV silicone or equal.

# 2.6 **PROTECTIVE COATINGS**

A. Corrosion Resistant Coatings: Asphaltic base liquid; Koppers Bitumastic 50.

# 2.7 OUTLET, PULL AND JUNCTION BOXES

- A. Junction and device boxes for dry locations shall be stamped steel, deep drawn one piece (without welds or tab connections), galvanized with knockouts for conduit or connector entrance.
- B. Junction and device boxes and fittings which are outdoors, below grade, or in wet or damp

#### CONDUITS AND BACKBOXES FOR COMMUNICATIONS

#### 27 0533 - 3

locations shall be galvanized cast iron or cast aluminum with threaded holes or hubs.

- C. Covers for junction boxes and fittings (and those device boxes which do not have device covers) shall be the same material and finish as the boxes to which they are attached. Neoprene gaskets shall be provided.
- D. Gang boxes shall be used wherever more than one device is used at one location.

### 2.8 ENCLOSURES

- A. Enclosures for communications equipment shall be NEMA 1 for use indoors or NEMA 3R for use outdoors. Enclosures for major equipment items shall be as specified under their respective sections.
- B. Provide equipment enclosures with engraved phenolic name plates (white with black background) giving the name and circuit identification of the enclosed device/equipment in one-quarter inch letters.

# 2.9 JUNCTION BOXES FOR UNDERGROUND CIRCUITS

A. Approved hand holes and vaults are those manufactured by Utility Vault or approved equivalent. See drawings for type and installation details.

#### 2.10 PULL STRING

A. Provide plastic or nylon pull string for all conduits. Pull string shall have not less than 200-pound tensile strength.

# PART 3 - EXECUTION

# 3.1 CONDUIT SIZING TABLE

A. Provide conduits for communications outlets as per drawings. Where not specified, minimum size shall be Trade Size 1.

# 3.2 RACEWAYS

- A. No length of run shall exceed 100 feet and shall not contain more than two 90-degree bends or the equivalent without a code size pull box. Provide pull boxes where necessary to comply with these requirements. Locate pull boxes in straight runs only, not as a replacement for an elbow.
- B. Conduits with an internal diameter of two inches or less shall have a bend radius at least 6 times the internal conduit diameter. Conduits greater than two inches shall have a bend radius at least

# CONDUITS AND BACKBOXES FOR COMMUNICATIONS

#### 27 0533 - 4

10 times the internal conduit diameter.

- C. Provide an insulated bushing on all conduits terminated in a cabinet and/ or pull boxes.
- D. Terminate conduits stubbed out above accessible ceiling space so that the conduit is parallel with the ceiling and provide an insulating bushing.

# 3.3 PULL BOXES

A. 1	Pull boxes,	as required	, shall be si	ized per the	following table:

	<b>TT</b> 7' 1.1	T .1		Width increase for
Metric designator	W1dth	Length	Depth	additional conduit mm
(trade size)	mm (in)	mm (in)	mm (in)	(in)
27 (1)	102 (4)	406 (16)	76 (3)	51 (2)
35 (1-1/4)	152 (6)	508 (20)	76 (3)	76 (3)
41 (1-1/2)	203 (8)	686 (27)	102 (4)	102 (4)
53 (2)	203 (8)	914 (36)	120 (4)	127 (5)
63 (2-1/2)	254 (10)	1067 (42)	127 (5)	152 (6)
78 (3)	305 (12)	1219 (48)	127 (5)	152 (6)
91 (3-1/2)	305 (12)	1372 (54)	152 (6)	152 (6)
103 (4)	381 (15)	1524 (60)	203 (8)	203 (8)

# 3.4 JUNCTION BOXES

A. Provide junction boxes as shown on the Drawings. 90 degree condulets (LB's) are not acceptable. Pull boxes shall be sized as follows:

				Width increase for
Metric designator	Width	Length	Depth	additional conduit mm
(trade size)	mm (in)	mm (in)	mm (in)	(in)
27 (1)	102 (4)	305 (12)	102 (4)	51 (2)
35 (1-1/4)	102 (4)	305 (12)	120 (4)	51 (2)
41 (1-1/2)	102 (4)	305 (12)	102 (4)	102 (4)
53 (2)	102 (4)	610 (24)	120 (4)	102 (4)
63 (2-1/2)	152 (6)	610 (24)	152 (6)	102 (4)
78 (3)	152 (6)	915 (36)	152 (6)	152 (6)
91 (3-1/2)	152 (6)	1220 (48)	152 (6)	152 (6)
103 (4)	152 (6)	1525 (60)	152 (6)	152 (6)

# 3.5 PULL STRINGS

A. Nylon type pull strings shall be included in all raceways over 10 feet long. Leave not less than 12 inches of slack at each end of the pull wire.

# CONDUITS AND BACKBOXES FOR COMMUNICATIONS

### 3.6 HARD CEILING BOXES

A. Hard ceiling boxes shall be secured in a manner that renders the faceplate flush and tight to the ceiling. Faceplate shall completely cover the opening cut into the ceiling tile.

# 3.7 RACEWAY RISER SLEEVES

A. Where it is necessary to place riser raceways to be between floors, install such with tops six inches above each floor to give continuous cable riser capability. Stuff sleeves with an approved non-combustible material such as rock wool to maintain floor fire separation.

END OF SECTION 27 0533

# CONDUITS AND BACKBOXES FOR COMMUNICATIONS

27 0533 - 6

### SECTION 27 0553 - IDENTIFICATIONS FOR COMMUNICATIONS

# PART 1 - GENERAL

### 1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete labeling of the telecommunications infrastructure.

#### 1.2 SCOPE

A. This section includes all telecommunications cables and the associated infrastructure in the telecommunications rooms and telecommunications cabinets.

#### 1.3 RELATED SECTIONS

A. See Section 27 0000 Part 1.7 for full information.

#### 1.4 QUALITY ASSURANCE

A. All cable identification tags and labels shall be installed in a neat and workmanlike manner.

#### PART 2 - PRODUCTS

# 2.1 LABEL TAGS – CABLE AND FACEPLATES

- A. The labels shall be machine generated. No hand labeling will be accepted.
- B. The label background shall be white with either black or blue ink.
- C. Lettering on sleeves shall be a minimum of 1/8-inch high
- D. Lettering on faceplates shall be a minimum of 5/16-inch high

### 2.2 ENGRAVED SIGNAGE

A. Engraved signage shall be laminate (color as specified) with engraved white letters.

# PART 3 - EXECUTION

#### IDENTIFICATIONS FOR COMMUNICATIONS

27 0553 - 1

# 3.1 INSTALLATION

# A. General

- 1. All horizontal (station) cables and outlets in which they terminate shall be identified by the Contractor at both ends of the wiring run. The standard nomenclature for the labeling is FF.RR.PP.nn, where FF = MDF or IDF number, RR=rack number, PP= patch panel number and nn= port(s) within the panel.
- 2. All fiber tie cables shall be labeled at each end. The standard nomenclature for labeling is "From <Room-1> to <Room-2>", where "Room-1" is the originating location and "Room-2" is the destination.
- B. Telecommunication Room and Telecom Enclosures shall be identified with building room numbers
- C. Horizontal (Station) Cables
  - 1. All cables will be labeled the same at both ends. The tag shall be secured to the sheath no more than 4 inches from the end of the cable. Each end of the UTP horizontal cables shall be labeled with the nomenclature FF.RR.PP.nn
  - 2. Port numbers shall be "1" "48"
- D. Copper Tie Cables
  - 1. Cables shall be labeled "From" "To", specifically: From MDF to IDF-x, where "x" = IDF Number
- E. Fiber Tie Cables
  - 1. Cables shall be labeled "From" "To", specifically: From MDF to IDF-x, where "x" = IDF Number
- F. Telecommunication Outlets (TO)
  - 1. Each TO shall be labeled at the top of the modular jack enclosure with the FF.RR.PP.nnnn
- G. Telecommunications Racks and Frames
  - 1. Labeling in the Main Equipment Room and Telecommunications Rooms shall be as per the Drawings. Labels shall be 1" white laminate with ½ inch black letters. Labels shall be placed left-to-right identifying "FRAME-1" through "FRAME-x", where "x" = number of racks/cabinets present.
- H. Patch Panels
  - 1. Patch panels shall be labeled identical to the cables and telecommunications outlets.
  - 2. Patch panels shall be labeled sequentially with 1/2" label on the left edge of the panel.

# IDENTIFICATIONS FOR COMMUNICATIONS

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# I. Door Signage

1. The exterior door of the Main Equipment Room (MDF) and Telecommunications Rooms (IDFs) shall have signage as per the drawings.

END OF SECTION 27 0553

# IDENTIFICATIONS FOR COMMUNICATIONS

27 0553 - 3

### SECTION 27 0800 - COMMISSIONING OF COMMUNICATIONS

### PART 1 - GENERAL

- 1.1 SUMMARY
  - A. Provide all labor, materials, tools, and equipment required for complete end-to-end testing of all copper and fiber optic cabling installed by this contract.
- 1.2 RELATED SECTIONS
  - A. See Section 27 0000 Part 1.7 for full information.

### 1.3 TESTING, IDENTIFICATION AND ADMINISTRATION

- A. All cables and termination points will be tested and labeled per specifications.
- B. Testing is required for all copper and fiber cables.
- C. All test results shall be forwarded to the Owner for certification. Results observed to be outside stated performance parameters shall be used by the Contractor for immediate correction.

#### 1.4 POST INSTALLATION SERVICES

- A. The Contractor shall provide on-site service as part of the warranty in the event of the failure of any installed components.
- B. The contractor will provide support and warranty for installed cabling.
  - 1. The Contractor will be the first contact point and will interface between manufacture and Owner for warranty issues.
  - 2. The Contractor will provide the Owner with contact information of the manufacture for warranty coverage prior to cable acceptance.
- C. The contractor will provide warranty certificate from the manufacturer prior to final acceptance.

#### 1.5 QUALITY ASSURANCE

A. See Section 270513

#### PART 2 - PRODUCTS

#### 2.1 TEST EQUIPMENT

- A. The Contractor shall provide all tools and instruments used to test the installed telecommunications signal cabling.
- B. Test instruments used by the Contractor shall be suitable for the purpose at hand and shall be of

#### COMMISSIONING OF COMMUNICATIONS

#### 27 0800 - 1

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industry-recognized manufacture. Note that copper testing parameters are written for Fluke DTX-1800 or newer tester.

- C. Tools leased by the Contractor are acceptable, provided the operator of the test instrument(s) has a sufficient degree of operational awareness to use the rented instrument(s) correctly and obtain test data that is both, accurate and relevant.
- D. Test equipment shall be within one year of calibration cycle at the completion of testing.

# 2.2 WARRANTY

- A. All telecommunications cable installed as part of a manufacturer's certified system for the new fiber backbone shall carry the manufacturer's warranty for a minimum of 20 years.
- B. The manufacturer shall provide certification attesting to on-site service as part of the warranty in the event of the failure of any installed balanced twisted pair cables, fiber-optic cables, telecommunications room terminations, telecommunications outlet terminations, or cross-connect cables.
- C. Such service shall be free of charge to the Owner and shall commence from the date of project acceptance and terminate not earlier than the twenty-year anniversary of that date.
- D. No warranty is expected as part of the copper cable re-terminations at frame upgrades; however, cable should be tested to show performance at same levels prior to the re-termination.

# PART 3 - EXECUTION

# 3.1 GENERAL REQUIREMENTS - COPPER

- A. The basic link shall be tested.
- B. All test results observed shall be used by the Contractor to determine any polarity and noise anomalies for immediate correction.
- C. Test results shall be used jointly by the Contractor and the Owner to determine the viability of each cable for transmission in accordance with the specifications of the cable manufacturer, and the requirements imposed by the transmission system. This shall form part of the acceptance procedure for the cable plant.
- D. All results obtained by use of pair-scanner testing shall be collated by WAO number and presented to the Owner's Representative at the conclusion of the testing. Test compilation shall be certified by the Contractor's technician performing the test.
- E. Hard copy of the test results will not be accepted, rather solid-state media containing test data and the appropriate application to display such in a Windows base environment is required.
- F. Test results shall be in the native format of the test equipment.

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# 3.2 GENERAL TESTING PARAMETERS - COPPER

- A. Copper cabling shall be tested after re-termination and shown to exhibit the same test results as prior to this work.
- B. Copper cabling shall be tested and certified after installation as follows and as required for cable manufacturer's warranty. Twisted-pair copper cable channels shall be tested for continuity as specified below, presence of ac/dc voltage, and performance. All cabling shall be tested for conformance to horizontal cable specifications as outlined herein and shall be tested according to test set manufacturer's instructions utilizing latest firmware and software. Testing shall include all electrical parameters as specified in Paragraph D below.
- C. All cables and termination hardware shall be 100 percent tested under installed conditions. All conductors of each installed cable shall be verified useable by Contractor prior to system acceptance. All cables shall be tested according to contract documents, manufacturer's warranty provisions, and best industry practices. If any of these are in conflict, Contractor shall comply with most stringent requirements. All defects in cabling system installation shall be repaired or replaced in order to ensure 100 percent useable conductors in all cables installed, at no additional cost to Owner.
- D. Balanced twisted pair testing shall provide certification and summary for all locations.
- E. All "category" cable paths shall be tested at each jack for the following parameters and meet the requirements imposed by the ANSI/TIA-568-C.2 and the manufacture's written specification. Testing will include the following parameters:
  - 1. Wire Map
  - 2. Cable Length
  - 3. Pair-to-pair NEXT
  - 4. Power Sum NEXT
  - 5. Attenuation
  - 6. Pair-to-Pair ELFEXT
  - 7. Power Sum ELFEXT
  - 8. Return Loss
  - 9. Propagation Delay
  - 10. Delay Skew

# 3.3 GENERAL TESTING REQUIREMENTS – FIBER OPTIC CABLES

- A. All fiber cable paths shall be tested utilizing a power meter to determine the following:
  - 1. Loss at both 1310 and 1510 nanometers (Single-mode)
  - 2. Cable length
- B. Test shall include fiber termination and if used, cassettes modules.
- C. End-to-end loss, including connectors shall be  $\leq 0.4$  dB. All strands are to be tested and certified.
- D. Contractor shall provide results from power meter testing of fiber optic cable to attest to proper

# COMMISSIONING OF COMMUNICATIONS

#### 27 0800 - 3
polarity and end-to-end performance of the installed fiber.

E. Contractor shall provide for the Owner as part of the as-built documentation the factory test results indicating the actual length and the measured end-to-end loss.

END OF SECTION 27 0800

# COMMISSIONING OF COMMUNICATIONS

27 0800 - 4

## SECTION 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.
- B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.
- 1.2 SECTION INCLUDES
  - A. Construction Requirements
  - B. Environmental Considerations
  - C. Site Specific Requirements
  - D. Permits and Inspections
- 1.3 RELATED SECTIONS
  - A. See Section 27 0000 Part 1.7 for full information.

#### 1.4 CONSTRUCTION REQUIREMENTS

- A. This contract shall be responsible for the plywood backboard material in the telecommunications spaces as shown on the Drawings. All walls shall be covered with plywood meeting the specifications and finished as per paragraph 2.3 below.
- B. Telecommunications Rooms (identified on the Drawings) will be built out as shown on the Drawings. This contract will be responsible for procurement and installation of specified components from the drywall out, i.e., all plywood backboards, telecommunications grounding busbars and bonding to such busbars as shown on the Drawings or deemed necessary for a complete system.

#### PART 2 - PRODUCTS

- 2.1 GENERAL
  - A. The use of a manufacturer's name and model or catalog number herein is for the purpose of establishing the product set, which the Contractor is to supply and install.
  - B. Quantities are to be determined by Contractor unless specified.

## COMMUNICATIONS EQUIPMENT ROOM FITTINGS

#### 27 1100 - 1

# 2.2 PRE-APPROVED PRODUCT SETS

- A. Fittings and all required ancillary components bench stock parts that are equal or greater than required to satisfy local AHJ.
- B. Telecommunications Grounding Busbar as per Section 27 0526.

#### 2.3 PLYWOOD BACKBOARD

- A. Do not use fire rated plywood. Backboard shall be 4' x 8' x <sup>3</sup>/<sub>4</sub>" standard lumber yard stock with a minimum grade of "AC".
- B. Finish plywood shall be painted on all exposed surfaces with two coats of white paint prior to installation of any equipment. Approved product is Benjamin-Moore Super Spec Hp 220 Latex Flat Fire Retardant P59 or equivalent.

# PART 3 - EXECUTION

## 3.1 GENERAL

- A. The installation must conform to TIA standards and comply with state and local codes.
- B. Installation shall be neat, well organized, and professional.
- C. The Contractor shall clean up the work area at the end of each day. Except as noted elsewhere in these specifications, all material removed or left over, and/or not being used shall be removed from the project
- D. All wall and floor penetrations shall be fire stopped before substantial completion.

#### 3.2 PLYWOOD BACKBOARD

- A. Coordination Coordinate with General Contractor and Electrical Contractor in the placement of electrical outlet boxes to assure proper depth and that box extenders are not used.
- B. Placement The backboard shall be 4' x 8' sheets, mounted vertically with the bottom of the plywood mounted 6" AFF with the best side toward the room. Electrical outlet plates shall be flush with finished plywood.
- C. Finish Plywood shall be painted prior to installation of any equipment. All exposed edges are to be finished with two coats of paint. Attach a complete copy of the MSDS to the finished backboard in each telecommunications space.
- D. Attachment Plywood shall be fastened to the wall by means of wall anchors utilizing galvanized, zinc plated, or stainless-steel hardware with a flat head. Finished installation shall have flush appearance with countersunk screw heads to prevent splitting of the plywood.

#### COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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#### 3.3 EQUIPMENT INSTALLATION

- A. Equipment shall be firmly held in place. Fastenings, supports, and hangers shall be adequate to support their loads.
- B. Installation shall satisfy the local AHJ in terms of seismic bracing.
- C. Where brackets or attachment points touch the walls, plywood backboard shall be in place between attachment point and wall. In no case shall any attachment be directly to drywall.

## 3.4 PREPARATION

- A. Before commencing work, the Contractor shall field-investigate the facility and ascertain if the physical and electrical conditions within the facility shall permit commencement of the Contractor's work.
- B. Telecommunications spaces must be cleaned and free of construction activities prior to installation of equipment.
- C. Any discrepancies, questions, or concerns noted at that time should be brought to the immediate attention of the Owner.

END OF SECTION 27 1100

# COMMUNICATIONS EQUIPMENT ROOM FITTINGS

27 1100 - 3

#### SECTION 27 1116 - COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.
- B. This section includes the minimum requirements for installation of equipment racks in Telecommunications Rooms.

#### 1.2 RELATED SECTIONS

A. See Section 27 0000 Part 1.7 for full information.

#### 1.3 QUALITY ASSURANCE

- A. All equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Strictly adhere to all TIA and BICSI<sup>®</sup> recommended installation practices when installing communications/data cabling.
- C. Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
  - 1. ANSI/TIA/568-D Series Commercial Building Telecommunications Cabling Standard,
  - 2. ANSI/TIA/569-D Commercial Building Standard for Telecommunications Pathways and Spaces,
  - 3. ANSI/TIA/607-D Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - 4. NFPA 70 National Electric Code  $(NEC^{\mathbb{R}})$
  - 5. BICSI<sup>®</sup> Telecommunications Distribution Methods Manual

## 1.4 SEISMIC CONSIDERATIONS

A. All equipment must meet or exceed the requirements of Seismic Zone 3 and satisfy the AHJ for

#### COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

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suitable components.

B. All design or engineering requirements imposed by the AHJ in relation to the mounting of telecommunications racks, ladder tray, bracing or associated components are the responsibility of this contract. This includes any requirements for stamped drawings of approved configuration.

# 1.5 SUBMITTALS

A. Provide Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

# PART 2 - PRODUCTS

# 2.1 GENERAL

A. Unless stated otherwise, Chatsworth (CPI) is the only approved product set for this project.

# 2.2 TELECOMMUNICATIONS RACK

- A. Freestanding telecommunications racks shall be installed in the Telecommunications Rooms as per the Drawings.
- B. Racks shall be Chatsworth 7' x 19". Part 55053-703.
- C. Chatsworth 3" channel rack-to-runway mounting plate with bracket. Part 12730-712.
- D. Chatsworth cable runway radius drop, Part 12100-712.

# 2.3 TELECOMMUNICATIONS RACK – FOUR POST

- A. A four-post server rack shall be installed in the Main Telecommunications Equipment Room (MDF).
- B. Racks shall be Chatsworth 7' x 19" x 35" (D), Part 15217-703.
- C. Chatsworth Runway Mounting Bracket, Part 15205-701.
- D. Chatsworth Equipment Support Rails, Part 15235-706.

# 2.4 LABELING

A. Reference Section 27 0553.

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# PART 3 - EXECUTION

## 3.1 GENERAL REQUIREMENTS

- A. Do not install any rack components until plywood backboards are installed (by others under the auspices of the General Contractor) and finished with two coats of fire-retardant paint.
- B. The racks shall be ganged as per the Drawings with 6" wide, double-sided, vertical wire management hardware placed between the racks and 6" wide at the ends of the row of racks. See Section 27 1123 Communications Cable Management and Ladder Racks for additional detail.
- C. Racks shall be firmly affixed to the floor using expanding anchors and Grade 5 (or greater) bolts.
- D. Top of rack shall be firmly affixed to ladder tray by means of a mounting plate as detailed in Section 27 1123.
- E. Rack and all metallic components shall be bonded to adjacent assemblies in accordance with ANSI/TIA-607-D.

END OF SECTION 27 1116

COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

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## SECTION 27 1119 - COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. General Conditions and other Division 27 0000 Communications requirements and sections, apply to the work specified in this section.
- B. Provide all labor, materials, tools, and equipment, including all support structure whether called out for or not, required for the complete installation of work called for in the Contract Documents.
- C. Install modular, rack mounted patch panels, and all support structure in the Equipment and Telecommunication Rooms (MDF/IDF) as outlined on drawings and specifications.
- 1.2 SECTION INCLUDES
  - A. Tie cables between MDF and IDF(s).
  - B. Copper station cables which are to be placed between the Work Area Outlets (WAO) and Telecommunications Rooms.
- 1.3 QUALITY ASSURANCE
  - A. All equipment shall be installed in a neat and workmanlike manner.
  - B. All materials shall be installed per manufacturer's specifications.

#### PART 2 - PRODUCTS

- 2.1 GENERAL
  - A. All products must be new and UL<sup>®</sup> Listed for their use.
- 2.2 PATCH PANELS COPPER
  - A. Existing patch panels to be re-used in new cabinet or rack.
- 2.3 PATCH PANELS FIBER
  - A. Fiber optic cable shall be terminated utilizing duplex LC connectors.

# PART 3 - EXECUTION

3.1 GENERAL

#### COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

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- A. All patch panels supporting the copper cabling shall be installed in 7' x 19" equipment racks in the telecommunications rooms.
- 3.2 INSTALLATION
  - A. A two RMU horizontal wire management panel shall be installed at the top of each rack. Additional horizontal wire management shall be installed as per drawings. See Section 27 1123 for additional detail.
- 3.3 PATCH PANELS
  - A. Patch panels shall be installed in equipment racks as per the details on the drawings. Particular attention is called to the placement of fiber patch panels and horizontal management.
  - B. All horizontal cable shall be terminated sequentially on patch panels.

END OF SECTION 27 1119

COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

27 1119 - 2

# SECTION 27 1123 - COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents
- B. Install ladder racks, cable trays, cable management systems, and all support structure in the Equipment and Telecommunication Rooms (MDF/IDF) as outlined on drawings and specifications.
- C. Equipment installed shall include:
  - 1. Ladder trays
  - 2. Vertical cable management
  - 3. Horizontal cable management
  - 4. Brackets and support pieces
  - 5. All related materials required to provide cable management and transition pathways within the Telecommunications Rooms of this project.

#### 1.2 RELATED SECTIONS

A. See Section 27 0000 Part 1.7 for full information.

#### 1.3 QUALITY ASSURANCE

- A. All equipment shall be installed in a neat and workmanlike manner.
- B. All materials shall be installed per standard installation practices and manufacturer's specifications.

## 1.4 SEISMIC CONSIDERATIONS

- A. All equipment must meet or exceed the requirements of Seismic Zone 3 and satisfy the AHJ for suitable components.
- B. All design or engineering requirements imposed by the AHJ in relation to the mounting of telecommunications racks, ladder tray, bracing or associated components are the responsibility of this contract.

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# PART 2 - PRODUCTS

# 2.1 GENERAL

- A. Chatsworth Products Incorporated (CPI) is the only approved product set for rack and ladder components listed in this Section.
- B. Attachment hardware not supplied in kits from manufacturer shall be Grade 5 or greater.

# 2.2 CHANNEL RACK-TO-RUNWAY

A. Use a Channel Rack-to-Runway Mounting Plate Kit to securely attach 12" wide cable tray to equipment racks. A kit is available from Chatsworth which includes all necessary bolts, washers, and nuts to make the proper attachment. CPI Part 12730-712

# 2.3 HORIZONTAL WIRE MANAGEMENT

A. Horizontal cabling managers shall be used to organize and contain patch cord runs from patch port to vertical cable wire management and are to be installed as per drawings.

# 2.4 VERTICAL CABLE MANAGEMENT

- A. Multiple racks shall be ganged with 6" wide, double-sided, vertical management hardware placed at the outside ends of the racks. Approved are:
  - 1. Chatsworth 11729-703.

# 2.5 LADDER RACK

- A. The telecommunications cable tray shall be 12" wide universal cable runway. CPI 10250-712
- B. End caps, CPI 10642-001 as required
- C. Cable runway radius drop, CPI 12100-712, two per rack receiving cables
- D. Butt splices, as required, will be accomplished using CPI 11299-701
- E. Ninety-degree junctions will be accomplished using CPI 11298-701
- F. Wall Angle Support Kit shall be 12" wide for attaching cable tray perpendicular to the wall. CPI 11421-712
- G. Grounding straps shall be CPI 40164-001 (available in lots of 25 each as CPI 40164-025). As an acceptable alternative to the CPI part, Contractor may fabricate grounding straps not more than

#### COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

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12" in length from #6AWG and two-hole compression lugs. Shop fabricated straps are subject to Owner's approval before installation.

# PART 3 - EXECUTION

## 3.1 GENERAL

A. Do not install any rack components until plywood backboards are installed and finished with two coats of paint.

## 3.2 INSTALLATION

- A. Equipment Racks
  - 1. Equipment racks shall be equipped with a mounting plate suitable for securing a 12-inch width cable tray from the rack to the backboard as per Section 27 1116.
  - 2. A two RU horizontal wire management panel shall be installed at the top of the rack. Additional horizontal wire management shall be installed as described above.
  - 3. Bolts used to attach the rack to the floor shall be stainless steel or zinc coated steel. Fasteners shall be Grade 5 or higher.
- B. Grounding and Bonding
  - 1. A copper bonding bus bar will be provided and installed on the backboard by others under the General Contractor. All racks and associated metallic components shall be bonded to the busbar in accordance with ANSI/TIA-607-D, National Electric Code<sup>®</sup>, and the Authority Having Jurisdiction.
  - 2. All paint and surface coatings are to be removed to bright metal at attachment points.
  - 3. Attachment is to be made with bolts that completely pass through the metal and are then firmly affixed by means of a star washer and a nut.
  - 4. Anti-oxidant compound is to be applied at attachment points where metals are bonded.

# 3.3 SEISMIC REQUIREMENTS

- A. This contract is responsible for satisfying all requirements pertaining to seismic compliance. All inspections or engineering associated with seismic compliance shall be included in this contract at no additional cost to the Owner.
- B. In the event an engineered drawing is required to satisfy the AHJ, a copy of same shall be included in the as-built documentation provided to the Owner.

#### END OF SECTION 27 1123

#### COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

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# SECTION 27 1126 - COMMUNICATIONS RACK MOUNTED POWER PROTECTION & POWER STRIPS

PART 1 - GENERAL

- 1.1 SUMMARY
  - A. Provide all labor, materials, tools, and equipment required for the complete installation of rack mounted power strips.
  - B. Provide and install power distribution as per documents and Drawings.
- 1.2 QUALITY ASSURANCE
  - A. All equipment shall be installed in a neat and workmanlike manner.
  - B. All materials shall be installed per standard installation practices and manufacturer's specifications.

# PART 2 - PRODUCTS

# 2.1 GENERAL

A. All products must be new and UL<sup>®</sup> Listed for their use.

# 2.2 POWER DISTRIBUTION UNITS - RACKS

A. Chatsworth 12848-705 or approved alternate.

# PART 3 - EXECUTION

# 3.1 GENERAL

- A. Follow manufacturer's instruction in terms of moving and mounting.
- B. Units are to be energized from an Owner provided and Owner installed UPS.
- 3.2 INSTALLATION

A. Rack PDU – install one in each rack with supplied brackets. Energize from UPS

END OF SECTION 27 1126

# COMMUNICATIONS RACK MOUNTED POWER PROTECTION & POWER STRIPS 27 1126 - 2

# SECTION 27 1323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This section includes the fiber backbone cable and the termination requirements.
- B. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

#### 1.2 QUALITY ASSURANCE

- A. See Section 27 0513.
- B. All cable shall be installed in a neat and workmanlike manner.

# PART 2 - PRODUCTS

#### 2.1 FIBER OPTIC CABLE

- A. Fiber shall be single-mode 9/125μm (OS2). A 12-strand fiber optic cable shall be placed between the Main Equipment Room (MDF) and each of the Telecommunications Rooms (IDFs). Rating shall be suitable for applications with a minimum rating of OFNP. Factory terminated, preconnectorized assembly is preferred. Jacket shall be yellow in color.
- B. Fiber assembly shall roll within the wall (similar to ANSI/TIA-568-D.3, Type-C.) The final fiber sequence will be as follows:

End	Fiber sequence for fiber (delivered at the LC connector)											
MDF	1	2	3	4	5	6	7	8	9	10	11	12
IDF	2	1	4	3	6	5	8	7	10	9	12	11

#### 2.2 PHYSICAL PROTECTION

A. Fiber optic cable shall be armored or installed in  $\frac{3}{4}$ " innerduct to provide physical protection.

# 2.3 FIBER OPTIC TERMINATION

A. Factory assembled and tested cassettes that transition from MPO duplex LC connectors, or are fusion spliced to preconnectorized duplex LC connectors, are preferred.

## COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

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- B. Rating for connector and cassette assemblies shall be OS2.
- C. Fiber shall present on user side on duplex LC connectors.
- D. Fiber bulkheads shall be blue in color
- E. Blank panels shall be used to cover all unused openings in the patch panel.

#### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Cable ties must be finger tight. The cable tie must not distort the outer jacket.
- B. The bend radius shall be no less than 10 times the outside cable jacket.
- C. Only Velcro<sup>®</sup>-type tie wraps shall be used to bundle cables on the back of the equipment racks and in the cable trays located in the Telecommunication Rooms.
- D. Retain factory test results for fiber assemblies and cassettes for inclusion in as-built documentation to be forwarded to Owner.

## 3.2 PREPARATION

A. Conduits - all conduits shall be inspected for bushings prior to cable installation.

#### 3.3 INSTALLATION

- A. Install per manufacturer's instructions.
- B. Install the fiber optic cable by hand or by using a mechanical pulling machine. If a mechanical pulling machine is used, equip the machine with a monitored or recording tension meter. Ensure that at no time the manufacturer's recommended maximum pulling tension is exceeded. Ensure that the central strength member and aramid yarn are attached directly to the pulling eye during cable pulling. Use pulling attachments, such as "basket grip" or "Chinese finger" to ensure that the optical and mechanical characteristics are not degraded during the fiber optic cable installation.
- C. Ensure that excess cable is coiled in a figure eight and fed manually when pulling through pull boxes and splice boxes by hand. Provide tension monitoring at all times during the pulling operation.

# 3.4 FIBER LABELING

#### COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

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- A. Label fiber patch panels in the MDF as: "Feed to IDF-x", where x = IDF number
- B. Label fiber patch panels in the IDF as "Feed from MDF"

END OF SECTION 27 1323

# COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

27 1323 - 3

# SECTION 27 1543 – COMMUNICATIONS FACEPLATES AND CONNECTORS

# PART 1 - GENERAL

## 1.1 SUMMARY

A. Provide all labor, materials, tools, and equipment required for the complete re-termination of jacks at adjusted or new frame room locations.

## 1.2 QUALITY ASSURANCE

A. See Section 27 0513.

# PART 2 - PRODUCTS

## 2.1 JACKS

- A. Product selection shall be:
  - 1. Horizontal (Station) Cable for WAO- The termination jack shall be an 8-pin (4 pair) modular jack rated for Category 6. Termination pin-out shall be T568B. Two jacks per location. Color shall blue at the faceplate and at the patch panel.
  - 2. Horizontal (Station) Cable for WAP and Cameras- The termination jack shall be an 8-pin (4 pair) modular jack rated for Category 6. Termination pin-out shall be T568B. Two jacks per location. Color shall yellow at the faceplate and at the patch panel.

# 2.2 FACEPLATES

A. Faceplates shall be thermoplastic with label windows.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install faceplates as per manufacturer's instructions. Care must be taken to provide a plumb and level appearance.
- B. All locations terminated above ACT ceiling shall be labelled on the ceiling grid below the outlet.

# END OF SECTION 27 1543

# COMMUNICATIONS FACEPLATES AND CONNECTORS

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# SECTION 27 1619 – PATCH CORDS

# PART 1 - GENERAL REQUIREMENT

- 1.1 GENERAL
  - A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.
- 1.2 WORK INCLUDED
  - A. Provide listed materials.
  - B. All copper patch cords shall be from the same manufacturer that is selected for the structured cable system.

## 1.3 QUALITY ASSURANCE

A. See Section 27 0513.

# PART 2 - PRODUCTS

# 2.1 FIBER PATCH CORDS

A. The Contractor shall supply single-mode fiber-optic riser patch cords in the quantities listed. Each patch cord shall be a duplex LC connector to duplex LC connector. The sheath and boot shall be dark blue and the fiber shall be yellow.

Length	<u>1M</u>	<u>2M</u>	<u>3M</u>
Quantity	2	8	4

# PART 3 - EXECUTION

- 3.1 GENERAL
  - A. Contractor to verify quantities and lengths with Owner prior to procurement of materials.
  - B. Deliver patch cords to the Owner in unopened packages.

# END OF SECTION 27 1619

# PATCH CORDS

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CSD - CVHS FIBER BACKBONE REPLACEMENT PIVOT ARCHITECTURE PROJECT NO. 1832.02

ISSUED FOR CONSTRUCTION AUGUST 28, 2020

