



City of Houston - Department of Aviation – Infrastructure Division

PROJECT MANUAL

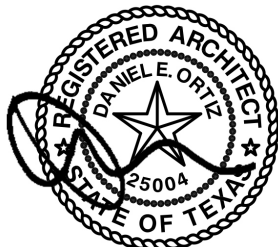
**TERMINAL D –Restroom Renovations at Gates D7,
D8, D9, D14 Nursery and D16 Misc.
IAH**

**PROJECT No.: PN971
CIP No.: [A-XXXX]**

VOLUME NO. 2 OF 2

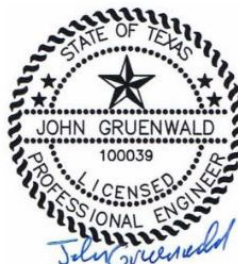
Divisions 21 through 33

MARCH 15, 2024



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END OF DOCUMENT

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**SECTION 21 1300
FIRE SUPPRESSION SPRINKLERS**

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 22 0553 - Identification for Plumbing Piping and Equipment.

1.4 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide; current edition.
- B. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2016.
- C. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.5 SUBMITTALS

- A. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B. Shop Drawings:
 - 1. Indicate hydraulic calculations, detailed pipe layout, elevations, hangers and supports, sprinklers, details. components and accessories. Indicate system controls.
 - 2. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.
 - 3. Wiring diagrams
- C. Welding certificates
- D. Qualification Data: For qualified Installer.
- E. Field Test Reports and Certificates
 - 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractors Material and Test Certificate for Aboveground Piping."
 - 2. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- F. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

- G. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.6 QUALITY ASSURANCE

- A. Maintain one copy of referenced design and installation standard on site.
- B. Comply with FM (AG) requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years experience and approved by manufacturer.
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems.
- E. Equipment and Components: Provide products that bear FM (AG) label or marking.
- F. 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.
- G. NFPA standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
- H. The system shall be calculated utilizing water supply test data obtained from flow tests conducted at the construction site by the consultant or fire protection contractor with the data, time and date of the test noted on the shop drawings. Method of testing shall include the use of at least one (1) residual pressure reading hydrant and one (1) flow hydrant.

1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Sprinklers, Valves, and Equipment:
 - 1. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
 - 2. Viking Corporation: www.vikinggroupinc.com/#sle.
 - 3. Approved equal
 - 4. Substitutions: See Section 01 6000 - Product Requirements.

2.2 SPRINKLER SYSTEM

- A. Sprinkler System: Provide coverage for building areas noted.
- B. Minimum design occupancy classification: Ordinary hazard, Group 1; comply with NFPA 13.
- C. Water Supply: Determine volume and pressure from water flow test data.
- D. Interface system with building fire and smoke alarm system.
- E. Provide fire department connections where indicated.

2.3 PIPING MATERIALS

- A. Comply with requirements in "PIPING SCHEDULE" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.4 STEEL PIPE AND FITTINGS

- A. Schedule 40, Galvanized and Black Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 40 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- B. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M,
- C. standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
- E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard
- F. pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Cast-Iron Flanges: ASME 16.1, Class 125.
- I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9
- K. Grooved-Joint, Steel-Pipe Appurtenances:
 - 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. National Fittings, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
 - 5. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
 - 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) Victaulic Company.

2.5 PIPE JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
 - 3. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.6 SPRINKLERS

- A. Suspended Ceiling Type: Concealed pendant type with matching push on escutcheon plate.
 - 1. Response Type: Quick.
 - 2. Coverage Type: Standard.
 - 3. Finish: Brass.

4. Escutcheon Plate Finish: Chrome plated.
5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- B. Exposed Area Type: Pendant type with guard.
 1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
 1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Escutcheon Plate Finish: Brass.
 5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- D. Storage Sprinklers: Pendant type with guard.
 1. Response Type: Standard.
 2. Coverage Type: Standard.
 3. Finish: Chrome plated.
 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- E. Guards: Finish to match sprinkler finish.

2.7 PIPING SPECIALTIES

PART 3 EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

3.2 WATER SUPPLY CONNECTIONS

- A. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
- B. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13. All sprinkler piping below 2-1/2" in diameter shall be Schedule 40 steel pipe.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install sprinkler piping with drains for complete system drainage.

- H. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- I. Fill sprinkler system piping with water.
- J. Electric heating cables on wet pipe sprinkler piping not allowed.
- K. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."
- L. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- D. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- E. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - 3. damaged.
- G. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for
 - 2. galvanized-steel pipe.
- J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- L. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal

- X. fittings with tools recommended by fitting manufacturer.
- Y. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both
- Z. piping systems.

3.5 VALVE AAND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and
- B. specialties according to NFPA 13 and authorities having jurisdiction.
- C. Install listed fire-protection shutoff valves supervised open, located to control sources of water
- D. supply except from fire-department connections. Install permanent identification signs
- E.
- F. indicating portion of system controlled by each valve.

3.6 INSTALLATION

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

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in
- B. NFPA 13.
- C. B. Identify system components, wiring, cabling, and terminals. Comply with requirements for
- D. identification specified in Division 26 Section "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest
 - 2. until no leaks exist.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls
 - 4. and equipment.
 - 5. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance"
 - 6. Chapter.
 - 7. Energize circuits to electrical equipment and devices.
 - 8. Start and run excess-pressure pumps.
 - 9. Coordinate with fire-alarm tests. Operate as required.
 - 10. Coordinate with fire-pump tests. Operate as required.
 - 11. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

3.9 **CLEANING**

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.10 **SPRINKLER SCHEDULES**

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: COncealed sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - 3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 - 4. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
- C.

END OF SECTION

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SECTION 22 0523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Bronze lift check valves.
 - 3. Bronze gate valves.
 - 4. Bronze globe valves.
 - 5. Lubricated plug valves.

1.3

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 RELATED SECTIONS:

- A. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
- B. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.5 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.6 SUBMITTALS

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

1.7 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:

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1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 2. ASME B31.1 for power piping valves.
 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.
- 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set angle, gate, and globe valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Set butterfly valves closed or slightly open.
 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
1. Handwheel: For valves other than quarter-turn types.
 2. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
 3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Solder Joint: With sockets according to ASME B16.18.
 3. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Hammond Valve.
 - e. Lance Valves; a division of Advanced Thermal Systems, Inc.
 - f. Legend Valve.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Red-White Valve Corporation.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - 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 or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

2.3 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.4 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.

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- g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - l. Zy-Tech Global Industries, Inc.
2. Description:
- a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service: Ball or butterfly valves.

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4. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
 - C. Select valves, except wafer types, with the following end connections:
 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 3. For Grooved-End Copper Tubing: Valve ends may be grooved.
- 3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Bronze Angle Valves: Class 125, bronze disc.
 3. Ball Valves: Two piece, full port, bronze with bronze trim.
 4. Bronze Swing Check Valves: Class 125, bronze disc.
 5. Bronze Gate Valves: Class 125, RS.
- B. Pipe NPS 2-1/2 and Larger:
 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Iron Ball Valves: Class 150.
 3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
 4. Iron, Grooved-End Butterfly Valves: 175 CWP.
 5. Iron Swing Check Valves: Class 125, metal seats.
 6. Iron Gate Valves: Class 125, OS&Y.

END OF SECTION 220523

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SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Metal pipe hangers and supports.
 2. Trapeze pipe hangers.
 3. Metal framing systems.
 4. Thermal-hanger shield inserts.
 5. Fastener systems.
 6. Pipe stands.
 7. Pipe positioning systems.
 8. Equipment supports.

1.3 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 RELATED SECTIONS:

- A. Division 21 fire-suppression piping Sections for pipe hangers for fire-suppression piping.

1.5 DEFINITIONS

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

1.6 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. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.7 SUBMITTALS

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

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- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.
 - 5. Equipment supports.
- C. Welding certificates.

1.8 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: Pregalvanized or hot dipped.
 - 3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 4. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless 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 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.

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4. Channels: Continuous slotted steel channel with inturred 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.

2.4 THERMAL-HANGER SHIELD INSERTS

- 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. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- 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.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- 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. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 2. Base: Stainless steel.
 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

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4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: One or more; Stainless Steel
 3. Vertical Members: Two or more protective-coated-steel channels.
 4. Horizontal Member: Protective-coated-steel channel.
 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 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, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, 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. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use

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- operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. 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.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. 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.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. 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.
- O. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. 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.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

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5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 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.

3.4 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.

3.5 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

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- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 - 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical

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adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- 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. 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 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. 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.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

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15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. 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.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): To control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

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SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 SUBMITTALS

- A. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Control Panels: Nameplates.
- B. Piping: Pipe markers.
- C. Pumps: Nameplates.
- D. Small-sized Equipment: Tags.
- E. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- F. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.

2.3 TAGS

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

2.4 STENCILS

2.5 PIPE MARKERS

- A. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

2.6 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.

END OF SECTION

**SECTION 22 0719
PLUMBING PIPING INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.
- E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum _____ years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

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

2.2 GLASS FIBER

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
 - 5. Owens Corning Corp: www.owenscorning.com.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Armacell LLC; AP Armaflex: www.armacell.us/#sle.
 - 2. K-Flex USA LLC; Insul-Tube: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation; _____: www.jm.com/#sle.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.

- d. Thickness: 10 mil.
- e. Connections: Brush on welding adhesive.
- B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- G. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
- H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.
- I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- J. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

- K. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

3.3 SCHEDULES

A. Plumbing Systems:

1. Domestic Hot Water Supply:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: all inch.
 - 2) Thickness: 1 inch.
2. Domestic Hot Water Recirculation:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - 2) Thickness: 1 inch.
3. Domestic Cold Water:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - 2) Thickness: 1 inch.
4. Roof Drain Bodies:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - b. Thickness: 1 inch.
5. Roof Drainage Run Horizontal at Roof Level:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - 2) Thickness: 1 inch.

END OF SECTION

**SECTION 22 1116
DOMESTIC WATER PIPING**

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. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Specialty valves.
 - 3. Flexible connectors.

1.3 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Water meters.
 - 6. Backflow preventers and vacuum breakers.
 - 7. Water penetration systems.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components.
- C. Comply with NSF 61 for potable domestic water piping and components.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Dresser Piping Specialties.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc; a Sensus company.
 - g. Viking Johnson; c/o Mueller Co.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 - 2. Description: CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO INC.

- c. Spears Manufacturing Company.
2. Description: CPVC or PVC four-part union. Include brass threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Hart Industries International, Inc.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Water Control Products.
 2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Kits:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Couplings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.

- b. Lochinvar Corporation.
- 2. Description:
 - a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Female threaded.
 - d. Lining: Inert and noncorrosive, thermoplastic.
- F. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Perfection Corporation; a subsidiary of American Meter Company.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Company.
 - 2. Description:
 - a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Male threaded or grooved.
 - d. Lining: Inert and noncorrosive, propylene.

2.5 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flex-Hose Co., Inc.
 - 2. Flexicraft Industries.
 - 3. Flex Pression, Ltd.
 - 4. Flex-Weld, Inc.
 - 5. Hyspan Precision Products, Inc.
 - 6. Mercer Rubber Co.
 - 7. Metraflex, Inc.
 - 8. Proco Products, Inc.
 - 9. Tozen Corporation.
 - 10. Unaflex, Inc.
 - 11. Universal Metal Hose; a Hyspan company
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- G. Install domestic water piping level without pitch and plumb.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. 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.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- R. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 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: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- E. Soldered Joints: 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."
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.
- E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.5 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.

- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.6 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.7 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.
- C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration for Plumbing Piping and Equipment".
- B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.10 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. 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.
 3. 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.
 4. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 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 for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.

- E. Prepare test and inspection reports.

3.12 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.13 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. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.14 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. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:
1. Soft copper tube, ASTM B 88, Type K; no joints.

- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be the following:
 - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. Soft copper tube, ASTM B 88, Type K; no joints.
- G. 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.
- H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

3.15 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated Memory-stop balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 22 1119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
1. Vacuum breakers.
 2. Backflow preventers.
 3. Balancing valves.
 4. Temperature-actuated water mixing valves.
 5. Strainers.
 6. Outlet boxes.
 7. Hose stations.
 8. Hose bibbs.
 9. Wall hydrants.
 10. Drain valves.
 11. Water hammer arresters.
 12. Air vents.
 13. Trap-seal primer valves.
 14. Trap-seal primer systems.

1.3 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
- B. Division 22 Section "Domestic Water Piping" for water meters.
- C. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.

1.5 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.6 SUBMITTALS

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

- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 PRODUCTS

2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Rain Bird Corporation.
 - f. Toro Company (The); Irrigation Div.
 - g. Watts Industries, Inc.; Water Products Div.
 - h. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrowhead Brass Products, Inc.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. Legend Valve.
 - e. MIFAB, Inc.
 - f. Prier Products, Inc.
 - g. Watts Industries, Inc.; Water Products Div.
 - h. Woodford Manufacturing Company.
 - i. Zurn Plumbing Products Group; Light Commercial Operation.

- j. Zurn Plumbing Products Group; Wilkins Div.
- 3. Standard: ASSE 1011.
- 4. Body: Bronze, nonremovable, with manual drain.
- 5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
- 6. Finish: Chrome or nickel plated.
- C. Reduced-Pressure-Principle Backflow Preventers :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.
 - 4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
 - 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 - 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 7. Configuration: Designed for horizontal, straight through flow.
 - 8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- D. Double-Check Backflow-Prevention Assemblies :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1015.
 - 3. Operation: Continuous-pressure applications, unless otherwise indicated.
 - 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 - 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 - 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 7. Configuration: Designed for horizontal, straight through flow.
 - 8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
- E. Beverage-Dispensing-Equipment Backflow Preventers :

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Plumbing Products Group; Wilkins Div.
 3. Standard: ASSE 1022.
 4. Operation: Continuous-pressure applications.
 5. Size: NPS 1/4 or NPS 3/8.
 6. Body: Stainless steel.
 7. End Connections: Threaded.
- F. Dual-Check-Valve Backflow Preventers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Ford Meter Box Company, Inc. (The).
 - f. Honeywell Water Controls.
 - g. Legend Valve.
 - h. McDonald, A. Y. Mfg. Co.
 - i. Mueller Co.; Water Products Div.
 - j. Watts Industries, Inc.; Water Products Div.
 - k. Zurn Plumbing Products Group; Wilkins Div.
 2. Standard: ASSE 1024.
 3. Operation: Continuous-pressure applications.
 4. Body: Bronze with union inlet.
- G. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Lancer Corporation.
 - c. Watts Industries, Inc.; Water Products Div.
 3. Standard: ASSE 1032.
 4. Operation: Continuous-pressure applications.
 5. Size: NPS 1/4 or NPS 3/8.
 6. Body: Stainless steel.
 7. End Connections: Threaded.
- H. Hose-Connection Backflow Preventers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.

- b. Watts Industries, Inc.; Water Products Div.
- c. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

2.2 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Flo Fab Inc.
 - c. ITT Industries; Bell & Gossett Div.
 - d. NIBCO INC.
 - e. TAC Americas.
 - f. Taco, Inc.
 - g. Watts Industries, Inc.; Water Products Div.
2. Type: Ball valve with two readout ports and memory setting indicator.
3. Body: Brass or bronze,
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Memory-Stop Balancing Valves :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corp.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.3 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armstrong International, Inc.
 - b. Conbraco Industries, Inc.
 - c. Honeywell Water Controls.
 - d. Leonard Valve Company.
 - e. Powers; a Watts Industries Co.
 - f. Symmons Industries, Inc.
 - g. Taco, Inc.
 - h. Watts Industries, Inc.; Water Products Div.
 - i. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig.
 4. Type: Thermostatically controlled water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded union inlets and outlet.
 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Tempered-Water Setting: Adjustable 105F
 9. Valve Finish: Rough bronze.
- B. Primary, Thermostatic, Water Mixing Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. Powers; a Watts Industries Co.
 - e. Symmons Industries, Inc.
 2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig.
 4. Type: Cabinet-type, thermostatically controlled water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded union inlets and outlet.
 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
 9. Tempered-Water Setting: 105F.
 10. Valve Finish: Rough bronze.
 11. Piping Finish: Copper.
 12. Cabinet: Factory-fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.
- C. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Honeywell Water Controls.
 - d. Lawler Manufacturing Company, Inc.
 - e. Leonard Valve Company.
 - f. Powers; a Watts Industries Co.

- g. Watts Industries, Inc.; Water Products Div.
- h. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
- 3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
- 4. Body: Bronze body with corrosion-resistant interior components.
- 5. Temperature Control: Adjustable.
- 6. Inlets and Outlet: Threaded.
- 7. Finish: Rough or chrome-plated bronze.
- 8. 8.

D. Primary Water Tempering Valves :

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Heat-Timer Corporation.
 - b. Holby Valve Co., Inc.
- 3. Standard: ASSE 1017, thermostatically controlled tempering valve, listed as tempering valve.
- 4. Pressure Rating: 125 psig minimum, unless otherwise indicated.
- 5. Body: Bronze.
- 6. Temperature Control: Manual.
- 7. Inlets and Outlet: Threaded.

2.4 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers :

- 1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
- 2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
- 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
- 5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
- 6. Drain: Factory-installed, hose-end drain valve.

2.5 OUTLET BOXES

A. Clothes Washer Outlet Boxes :

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Guy Gray Manufacturing Co., Inc.
 - c. IPS Corporation.
 - d. LSP Products Group, Inc.
 - e. Oatey.
 - f. Plastic Oddities; a division of Diverse Corporate Technologies.
 - g. Symmons Industries, Inc.
 - h. Watts Industries, Inc.; Water Products Div.

- i. Whitehall Manufacturing; a div. of Acorn Engineering Company.
 - j. Zurn Plumbing Products Group; Light Commercial Operation.
 2. Mounting: Recessed.
 3. Material and Finish: Stainless-steel box and faceplate.
 4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
 5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
 6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
 7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
 8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.
- B. Icemaker Outlet Boxes :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. LSP Products Group, Inc.
 - d. Oatey.
 - e. Plastic Oddities; a division of Diverse Corporate Technologies.
 2. Mounting: Recessed.
 3. Material and Finish: Stainless-steel box and faceplate.
 4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
 5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.6 HOSE BIBBS

- A. Hose Bibbs :
1. Standard: ASME A112.18.1 for sediment faucets.
 2. Body Material: Bronze.
 3. Seat: Bronze, replaceable.
 4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
 5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
 6. Pressure Rating: 125 psig.
 7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
 9. Finish for Service Areas: Rough bronze.
 10. Finish for Finished Rooms: Chrome or nickel plated.
 11. Operation for Equipment Rooms: Wheel handle or operating key.
 12. Operation for Service Areas: Operating key.
 13. Operation for Finished Rooms: Operating key.
 14. Include operating key with each operating-key hose bibb.
 15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

B. Moderate-Climate Wall Hydrants :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Woodford Manufacturing Company.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011; and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounting with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet: Exposed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011; and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): Two with each wall hydrant.

C. Vacuum Breaker Wall Hydrants :

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrowhead Brass Products, Inc.
 - b. Mansfield Plumbing Products LLC.
 - c. McDonald, A. Y. Mfg. Co.
 - d. Prier Products, Inc.
 - e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Woodford Manufacturing Company.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.
3. Standard: ASSE 1019, Type A or Type B.
4. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
5. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
6. Pressure Rating: 125 psig.
7. Operation: Loose key.
8. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

9. Inlet: NPS 1/2 or NPS 3/4.
10. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.7 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves :
 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 2. Pressure Rating: 400-psig minimum CWP.
 3. Size: NPS 3/4.
 4. Body: Copper alloy.
 5. Ball: Chrome-plated brass.
 6. Seats and Seals: Replaceable.
 7. Handle: Vinyl-covered steel.
 8. Inlet: Threaded or solder joint.
 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
- B. Gate-Valve-Type, Hose-End Drain Valves :
 1. Standard: MSS SP-80 for gate valves.
 2. Pressure Rating: Class 125.
 3. Size: NPS 3/4.
 4. Body: ASTM B 62 bronze.
 5. Inlet: NPS 3/4 threaded or solder joint.
 6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
- C. Stop-and-Waste Drain Valves :
 1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
 2. Pressure Rating: 200-psig minimum CWP or Class 125.
 3. Size: NPS 3/4.
 4. Body: Copper alloy or ASTM B 62 bronze.
 5. Drain: NPS 1/8 side outlet with cap.

2.8 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters :
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. PPP Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products Inc.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASSE 1010 or PDI-WH 201.
 3. Type: Metal bellows.
 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.9 AIR VENTS

- A. Bolted-Construction Automatic Air Vents :

1. Body: Bronze.
 2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
 3. Float: Replaceable, corrosion-resistant metal.
 4. Mechanism and Seat: Stainless steel.
 5. Size: NPS 1/2 minimum inlet.
 6. Inlet and Vent Outlet End Connections: Threaded.
- B. Welded-Construction Automatic Air Vents :
1. Body: Stainless steel.
 2. Pressure Rating: 150-psig minimum pressure rating.
 3. Float: Replaceable, corrosion-resistant metal.
 4. Mechanism and Seat: Stainless steel.
 5. Size: NPS 3/8 minimum inlet.
 6. Inlet and Vent Outlet End Connections: Threaded.

2.10 TRAP-SEAL PRIMER VALVES

- A. Supply-Type, Trap-Seal Primer Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
 2. Standard: ASSE 1018.
 3. Pressure Rating: 125 psig minimum.
 4. Body: Bronze.
 5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
 6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
- B. Drainage-Type, Trap-Seal Primer Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
 3. Size: NPS 1-1/4 minimum.
 4. Material: Chrome-plated, cast brass.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install thermometers and water regulators if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each control valve, solenoid valve, and pump.
- G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- H. Install water hammer arresters in water piping according to PDI-WH 201.
- I. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- J. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- K. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Pressure vacuum breakers.
 2. Intermediate atmospheric-vent backflow preventers.
 3. Reduced-pressure-principle backflow preventers.
 4. Double-check backflow-prevention assemblies.
 5. Carbonated-beverage-machine backflow preventers.
 6. Dual-check-valve backflow preventers.
 7. Calibrated balancing valves.
 8. Primary, thermostatic, water mixing valves.
 9. Outlet boxes.
 10. Hose stations.
 11. Supply-type, trap-seal primer valves.

- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

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SECTION 22 1316
SANITARY WASTE AND VENT PIPING

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. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.3 BUY AMERICAN COMPLIANCE

- 1.4 THE CONTRACTOR SHALL COMPLY WITH THE APPLICABLE FAA BUY AMERICAN PREFERENCE REQUIREMENTS SET FORTH IN TITLE 49 OF THE UNITED STATES CODE § 50101, BABA AND OTHER RELATED MADE IN AMERICA LAWS, US STATUTES, GUIDANCE, AND FAA POLICIES WHICH PROVIDE THAT FEDERAL FUNDS MAY NOT BE OBLIGATED UNLESS ALL IRON, STEEL, AND MANUFACTURED GOODS USED IN AIP FUNDED PROJECTS ARE PRODUCED IN THE UNITED STATES, UNLESS THE FEDERAL AVIATION ADMINISTRATION HAS ISSUED A WAIVER FOR THE PRODUCT; THE PRODUCT IS LISTED AS AN EXCEPTED ARTICLE, MATERIAL OR SUPPLY IN FEDERAL ACQUISITION REGULATION SUBPART 25.108; OR IS INCLUDED IN THE FAA NATIONWIDE BUY AMERICAN WAIVERS ISSUED LIST. IF THE CONTRACTOR PROCURES ANY CAPITAL ITEMS WITH FEDERAL FUNDS, IT IS THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN THE BUY AMERICA CERTIFICATION UNDER SUCH REGULATIONS

1.5 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.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.
- C. Field quality-control reports.

1.7 QUALITY ASSURANCE

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

- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Extra Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Dallas Specialty & Mfg. Co.
 - c. Fernco Inc.
 - d. Matco-Norca, Inc.
 - e. MIFAB, Inc.
 - f. Mission Rubber Company; a division of MCP Industries, Inc.
 - g. Stant.
 - h. Tyler Pipe.
 - 2. Standards: ASTM C 1277 and CISPI 310.
 - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. MIFAB, Inc.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Stant.
 - g. Tyler Pipe.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes

- to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company; a division of MCP Industries, Inc.
 - 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- 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. 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. 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. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. 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."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install underground PVC piping according to ASTM D 2321.
- O. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- P. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. 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.
- D. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sewage pump discharge.
 - 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 - 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Comply with requirements for backwater valve specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 4. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
 8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- K. Install supports for vertical PVC piping every 48 inches.
- L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Install horizontal backwater valves with cleanout cover flush with floor in pit with pit cover flush with floor.
 6. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
 7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. 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.

3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage 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. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.

3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of 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.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings and solvent stack fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings and solvent stack fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
 1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
 1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 22 1319
SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Trench drains.
 - 4. Roof flashing assemblies.
 - 5. Through-penetration firestop assemblies.
 - 6. Miscellaneous sanitary drainage piping specialties.
 - 7. Flashing materials.

1.3 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Grease interceptors.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Drainage 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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Josam Company; Blucher-Josam Div.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk, brass plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Oatey.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Light Commercial Operation.
 - h. Zurn Plumbing Products Group; Specification Drainage Operation.
 - i. Josam Company; Josam Div.
 - j. Kusel Equipment Co.
 - k. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

- I. Josam Company; Blucher-Josam Div.
 2. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule cleanout.
 3. Size: Same as connected branch.
 4. Type: Adjustable housing Cast-iron soil pipe with cast-iron ferrule.
 5. Body or Ferrule: Cast iron.
 6. Clamping Device: Required.
 7. Outlet Connection: Spigot.
 8. Closure: Brass plug with straight threads and gasket.
 9. Adjustable Housing Material: Cast iron with.
 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 11. Frame and Cover Shape: Round.
 12. Top Loading Classification: Extra Heavy Duty.
 13. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.
 14. Standard: ASME A112.3.1.
 15. Size: Same as connected branch.
 16. Housing: Stainless steel.
 17. Closure: Stainless steel with seal.
 18. Riser: Stainless-steel drainage pipe fitting to cleanout.
- C. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.36.2M. Include wall access.
 3. Size: Same as connected drainage piping.
 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 5. Closure: Countersunk, plug.
 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 7. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
 8. Wall Access: Round, wall-installation frame and cover.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products Inc.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.

- i. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.6.3.
 3. Pattern: Area Floor Funnel floor drain.
 4. Body Material: Gray iron.
 5. Seepage Flange: Required.
 6. Anchor Flange: Required.
 7. Clamping Device: Not required.
 8. Outlet: Bottom.
 9. Coating on Interior and Exposed Exterior Surfaces: Not required.
 10. Sediment Bucket: Not required.
 11. Top or Strainer Material: Nickel bronze.
 12. Top of Body and Strainer Finish: Nickel bronze.
 13. Top Shape: Round.
 14. Top Loading Classification: Extra Heavy-Duty.
 15. Trap Material: Cast iron.
 16. Trap Pattern: Standard P-trap.
 17. Trap Features: Trap-seal primer valve drain connection.
- B. Plastic Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. Josam Company; Josam Div.
 - d. Oatey.
 - e. Plastic Oddities; a division of Diverse Corporate Technologies.
 - f. Sioux Chief Manufacturing Company, Inc.
 - g. Zurn Plumbing Products Group; Light Commercial Operation.
 2. Standard: ASME A112.6.3.
 3. Material: PVC.
 4. Seepage Flange: Required.
 5. Clamping Device: Required.
 6. Outlet: Bottom.
 7. Sediment Bucket: Not required.
 8. Top or Strainer Material: Stainless steel.
 9. Top of Body and Strainer Finish: Nickel bronze.
 10. Top Shape: Square.
 11. Dimensions of Top or Strainer: 12"x 12"
 12. Trap Material: Cast iron.
 13. Trap Pattern: Standard P-trap.

2.3 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
 - c. c.

- B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - 1. Open-Top Vent Cap: Without cap.
 - 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Firestop Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
 - 2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
 - 3. Size: Same as connected soil, waste, or vent stack.
 - 4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - 5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 - 6. Special Coating: Corrosion resistant on interior of fittings.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 - 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 - 2. Size: Same as connected waste piping.
- B. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
 - 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- E. Sleeve Flashing Device:
 - 1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top

of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

G. Vent Caps Insert drawing designation if any:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. Size: Same as connected stack vent or vent stack.

H. Expansion Joints:

1. Standard: ASME A112.21.2M.

2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.

4. Size: Same as connected soil, waste, or vent piping.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.

2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.

3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft. thickness.

2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- I. Assemble open drain fittings and install with top of hub 2 inches above floor.
- J. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- K. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- N. Install vent caps on each vent pipe passing through roof.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 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 221319

**SECTION 22 3000
PLUMBING EQUIPMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water heaters.
 - 1. Commercial, electric, storage, domestic-water heaters.
 - 2. Thermostat-control, electric, tankless, domestic-water heaters.
 - 3. Domestic-water heater accessories.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 SUBMITTALS

- A. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Provide electrical characteristics and connection requirements.
- B. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater, from manufacturer.
- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- 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.
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 2. Verify available warranties for units and components with manufacturers listed in Part 2 articles.
 3. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Three years.

PART 2 PRODUCTS

2.1 WATER HEATER MANUFACTURERS

- A. Commercial Electric, Storage, Domestic-Water Heaters
1. Subject to compliance with requirements, provide products by one of the following:
 - a. American Water Heaters.
 - b. GSW Water Heating.
 - c. HESco Industries, Inc.
 - d. Lochinvar Corporation
 - e. Precision Boilers, Inc.
 - f. PVI Industries, LLC.
 - g. RECO USA.
 - h. Rheem Manufacturing Company.
 - i. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - j. State Industries.

2.2 COMMERCIAL ELECTRIC WATER HEATERS

- A. Standard: UL 1453.
- B. Storage-Tank Construction: Non-ASME-code, steel vertical arrangement.
1. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - a. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - b. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 2. Pressure Rating: 150 psig.
 3. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
- C. Factory-Installed Storage-Tank Appurtenances:
1. Anode Rod: Replaceable magnesium.
 2. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 3. Insulation: Comply with ASHRAE/IESNA 90.1.

4. Jacket: Steel with enameled finish.
5. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
6. Temperature Control: Adjustable thermostat.
7. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
8. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

D. Special Requirements: NSF 5 construction

2.3 TANKLESS DOMESTIC-WATER HEATER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chromomite Laboratories, Inc.(Basis of Design)
2. Eemax
3. Approved equal

B. Materials

1. Rugged cast aluminum housing, Celcon plastic element assembly with nichrome coils.

C. Operating requirements:

1. Minimum operating flow: 0.35 gpm
2. Minimum operating pressure: 25 psi
3. Maximum operating pressure: 80 psi
4. Maximum pressure: 150 psi
5. Maximum operating temperature: 160 deg F

D. Accessories

1. Faucet flow controls
2. Compression fittings

E. Schedule

1. Refer to schedule on drawings

2.4 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL Inc.
 - b. Flexcon Industries.
 - c. Honeywell International Inc.
 - d. Pentair Pump Group (The); Myers.
 - e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - f. State Industries.
 - g. Taco, Inc.
2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

- b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
- c. Air-Charging Valve: Factory installed.
- 4. Capacity and Characteristics:
 - a. Working-Pressure Rating: 100 psig.
 - b. Capacity Acceptable: 2 gal. minimum.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- D. Heat-Trap Fittings: ASHRAE 90.2.
- E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated memory-stop balancing valves to provide balanced flow through each domestic-water heater.
 - 1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 2. Comply with requirements for balancing valves specified in Division 22 Section "Domestic Water Piping Specialties."
- F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.
- G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
- L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."
- F. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- G. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- H. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

- I. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- J. Fill electric, domestic-water heaters with water.
- K. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial and tankless, electric, domestic-water heaters.

END OF SECTION

**SECTION 22 4010
PLUMBING FIXTURES**

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 1. Faucets for lavatories bathtub/showers showers and sinks.
 2. Flushometers.
 3. Toilet seats.
 4. Protective shielding guards.
 5. Fixture supports.
 6. Interceptors.
 7. Water closets.
 8. Urinals.
 9. Lavatories.
 10. Commercial sinks.
 11. Kitchen sinks.
 12. Service sinks.
 13. Service basins.
 14. Owner-furnished fixtures.

1.3 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.

- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.5 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 - 3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 4. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
 - 5. Stainless-Steel Residential Sinks: ASME A112.19.3.
 - 6. Vitreous-China Fixtures: ASME A112.19.2M.
 - 7. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 - 8. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucets: ASME A112.18.1.
 - 5. Hose-Connection Vacuum Breakers: ASSE 1011.

6. Hose-Coupling Threads: ASME B1.20.7.
 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 8. NSF Potable-Water Materials: NSF 61.
 9. Pipe Threads: ASME B1.20.1.
 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 11. Supply Fittings: ASME A112.18.1.
 12. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1.
 3. Dishwasher Air-Gap Fittings: ASSE 1021.
 4. Manual-Operation Flushometers: ASSE 1037.
 5. Plastic Tubular Fittings: ASTM F 409.
 6. Brass Waste Fittings: ASME A112.18.2.
 7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Flexible Water Connectors: ASME A112.18.6.
 2. Floor Drains: ASME A112.6.3.
 3. Hose-Coupling Threads: ASME B1.20.7.
 4. Hot-Water Dispensers: ASSE 1023 and UL 499.
 5. Off-Floor Fixture Supports: ASME A112.6.1M.
 6. Pipe Threads: ASME B1.20.1.
 7. Plastic Toilet Seats: ANSI Z124.5.
 8. Supply and Drain Protective Shielding Guards: ICC A117.1.
- 1.7 WARRANTY
- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 2. Warranty Period for Commercial Applications: One year(s) from date of Substantial Completion.
- 1.8 EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 2. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
 3. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.

4. Flushometer Tank, Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than 2 of each type.

PART 2 PRODUCTS- REFER TO DRAWINGS

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Install counter-mounting fixtures in and attached to casework.
- E. Install fixtures level and plumb according to roughing-in drawings.
- F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- H. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- I. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- J. Install toilet seats on water closets.
- K. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- L. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- M. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- N. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- O. Install traps on fixture outlets.
 1. Exception: Omit trap on fixtures with integral traps.
 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- P. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Escutcheons for Plumbing Piping."
- Q. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.4 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.
- D. Install fresh batteries in sensor-operated mechanisms.

3.5 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.6 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

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SECTION 22 4700
DRINKING FOUNTAINS AND WATER COOLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following drinking fountains and water coolers and related components:
 - 1. Pressure water coolers.
 - 2. Fixture supports.

1.3 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 DEFINITIONS

- A. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Cast Polymer: Dense, cast-filled-polymer plastic.
- C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
- D. Fitting: Device that controls flow of water into or out of fixture.
- E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
- F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
- G. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.5 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filter Cartridges: Equal to 5 percent of amount installed for each type and size indicated, but no fewer than 5 of each.

PART 2 PRODUCTS

2.1 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Co.
 - 2. MIFAB Manufacturing, Inc.
 - 3. Smith, Jay R. Mfg. Co.
 - 4. Tyler Pipe; Wade Div.
 - 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
 - 1. Type I: Hanger-type carrier with two vertical uprights.
 - 2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
 - 3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

- B. Use mounting frames for recessed water coolers, unless otherwise indicated.
- C. Set remote water coolers on floor, unless otherwise indicated.
- D. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Escutcheons for Plumbing Piping."
- G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

SECTION 23 0200
BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all Work herein.
- B. The Contract Drawings indicate the extent and general arrangement of the systems. If any departure from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted to the Architect for approval as soon as practicable. No such departures shall be made without the prior written approval of the Architect.
- C. Notwithstanding any reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, such reference shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect, expressed in writing, is equal to that specified.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 SCOPE OF WORK

- A. The Work included under this Contract consists of the furnishing and installation of all equipment and material necessary and required to form the complete and functioning systems in all of its various phases, all as shown on the accompanying Drawings and/or described in these Specifications. The contractor shall review all pertinent drawings, including those of other contracts prior to commencement of Work.
- B. This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, transportation, storage, equipment, utilities, all required permits, licenses and inspections. All work performed under this Section shall be in accordance with the Project Manual, Drawings and Specifications and is subject to the terms and conditions of the Contract.
- C. The approximate locations of Mechanical (HVAC) items are indicated on the Drawings. These Drawings are not intended to give complete and accurate details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the building, and will in all cases be subject to the Review of the Owner or Engineer, who reserves the right to make any reasonable changes in the locations indicated without additional cost to the Owner.

- D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.
- E. All discrepancies between the Contract Documents and actual job-site conditions shall be reported to the Owner or Engineer so that they will be resolved prior to the bidding, where this cannot be done at least 7 working days prior to bid; the greater or more costly of the discrepancy shall be bid. All labor and materials required to perform the work described shall be included as part of this Contract.
- F. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and fully operating system in cooperation with other trades.
- G. It is the intent of the above "Scope" to give the Contractor a general outline of the extent of the Work involved; however, it is not intended to include each and every item required for the Work. Anything omitted from the "Scope" but shown on the Drawings, or specified later, or necessary for a complete and functioning heating, ventilating and air conditioning system shall be considered a part of the overall "Scope".
- H. The Contractor shall rough-in fixtures and equipment furnished by others from rough-in and placement drawings furnished by others. The Contractor shall make final connection to fixtures and equipment furnished by others.

1.4 SCHEMATIC NATURE OF CONTRACT DOCUMENTS

- A. The contract documents are schematic in nature in that they are only to establish scope and a minimum level of quality. They are not to be used as actual working construction drawings. The actual working construction drawings shall be the approved shop drawings.
- B. All duct or pipe or equipment locations as indicated on the documents do not indicate every transition, offset, or exact location. All transitions, offsets clearances and exact locations shall be established by actual field measurements, coordination with the structural, architectural and reflected ceiling plans, and other trades. Submit shop drawings for approval.
- C. All transitions, offsets and relocations as required by actual field conditions shall be performed by the contractor at no additional cost to the owner.
- D. Additional coordination with electrical contractor may be required to allow adequate clearances of electrical equipment, fixtures and associated appurtenances. Contractor to notify Architect and Engineer of unresolved clearances, conflicts or equipment locations.

1.5 SITE VISIT AND FAMILIARIZATION

- A. Before submitting a bid, it will be necessary for each Contractor whose work is involved to visit the site and ascertain for himself the conditions to be met therein in installing his work and make due provision for same in his bid. It will be assumed that this Contractor in submitting his bid has visited the premises and that his bid covers all work necessary to properly install the equipment shown. Failure on the part of the Contractor to comply with this requirement shall not be considered justification for the omission or faulty installation of any work covered by these Specifications and Drawings.
- B. Understand the existing utilities from which services will be supplied; verify locations of utility services, and determine requirements for connections.
- C. Determine in advance that equipment and materials proposed for installation fit into the confines indicated.

1.6 WORK SPECIFIED IN OTHER SECTIONS

- A. Finish painting is specified. Prime and protective painting are included in the work of this Division.

- B. Owner and General Contractor furnished equipment shall be properly connected to Mechanical (HVAC) systems.
- C. Furnishing and installing all required Mechanical (HVAC) equipment control relays and electrical interlock devices, conduit, wire and J-boxes are included in the Work of this Division.

1.7 PERMITS, TESTS, INSPECTIONS

- A. Arrange and pay for all permits, fees, tests, and all inspections as required by governmental authorities.

1.8 DATE OF FINAL ACCEPTANCE

- A. The date of final acceptance shall be the date of owner occupancy, or the date all punch list items have been completed or final payment has been received. Refer to Division One for additional requirements.
- B. The date of final acceptance shall be documented in writing and signed by the architect, owner and contractor.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Deliver products to the project at such time as the project is ready to receive the equipment, pipe or duct properly protected from incidental damage and weather damage.
- C. Damaged equipment, duct or pipe shall be promptly removed from the site and new, undamaged equipment, pipe and duct shall be installed in its place promptly with no additional charge to the Owner.

1.10 NOISE AND VIBRATION

- A. The heating, ventilating and air conditioning systems, and the component parts there of, shall be guaranteed to operate without objectionable noise and vibration.
- B. Provide foundations, supports and isolators as specified or indicated, properly adjusted to prevent transmission of vibration to the Building structure, piping and other items.
- C. Carefully fabricate ductwork and fittings with smooth interior finish to prevent turbulence and generation or regeneration of noise.
- D. All equipment shall be selected to operate with minimum of noise and vibration. If, in the opinion of the Architect, objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of the Work, the Contractor shall rectify such conditions without extra cost to the Owner.

1.11 APPLICABLE CODES

- A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.
- B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.
- C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements which includes and is not limited to the following nationally accepted codes and standards:
 - 1. Air Moving & Conditioning Association, AMCA.
 - 2. American Standards Association, ASA.
 - 3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.

4. American Society of Mechanical Engineers, ASME.
 5. American Society of Plumbing Engineers, ASPE.
 6. American Society of Testing Materials, ASTM.
 7. American Water Works Association, AWWA.
 8. National Bureau of Standards, NBS.
 9. National Fire Protection Association, NFPA.
 10. Sheet Metal & Air Conditioning Contractors' National Association, SMACNA.
 11. Underwriters' Laboratories, Inc., UL.
 12. International Energy Conservation Code, IECC.
 13. International Fire Code.
 14. International Gas Code.
- D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.
- E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

1.12 DEFINITIONS AND SYMBOLS

- A. General Explanation: A substantial amount of construction and Specification language constitutes definitions for terms found in other Contract Documents, including Drawings which must be recognized as diagrammatic and schematic in nature and not completely descriptive of requirements indicated thereon. Certain terms used in Contract Documents are defined generally in this article, unless defined otherwise in Division 1.
- B. Definitions and explanations of this Section are not necessarily either complete or exclusive, but are general for work to the extent not stated more explicitly in another provision of the Contract Documents.
- C. Indicated: The term "Indicated" is a cross-reference to details, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications and to similar means of recording requirements in Contract Documents. Where such terms as "Shown", "Noted", "Scheduled", "Specified" and "Detailed" are used in lieu of "Indicated", it is for the purpose of helping the reader locate cross-reference material, and no limitation of location is intended except as specifically shown.
- D. Directed: Where not otherwise explained, terms such as "Directed", "Requested", "Accepted", and "Permitted" mean by the Architect or Engineer. However, no such implied meaning will be interpreted to extend the Architect's or Engineer's responsibility into the Contractor's area of construction supervision.
- E. Reviewed: Where used in conjunction with the Engineer's response to submittals, requests for information, applications, inquiries, reports and claims by the Contractor the meaning of the term "Reviewed" will be held to limitations of Architect's and Engineer's responsibilities and duties as specified in the General and Supplemental Conditions. In no case will "Reviewed" by Engineer be interpreted as a release of the Contractor from responsibility to fulfill the terms and requirements of the Contract Documents.

- F. Furnish: Except as otherwise defined in greater detail, the term "Furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
- G. Install: Except as otherwise defined in greater detail, the term "Install" is used to describe operations at the project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance.
- H. Provide: Except as otherwise defined in greater detail, the term "Provide" is used to mean "Furnish and Install", complete and ready for intended use, as applicable in each instance.
- I. Installer: Entity (person or firm) engaged by the Contractor or its subcontractor or Sub-contractor for performance of a particular unit of work at the project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance. It is a general requirement that such entities (Installers) be expert in the operations they are engaged to perform.
- J. Imperative Language: Used generally in Specifications. Except as otherwise indicated, requirements expressed imperatively are to be performed by the Contractor. For clarity of reading at certain locations, contrasting subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or when so noted by other identified installers or entities.
- K. Minimum Quality/Quantity: In every instance, the quality level or quantity shown or specified is intended as minimum quality level or quantity of work to be performed or provided. Except as otherwise specifically indicated, the actual work may either comply exactly with that minimum (within specified tolerances), or may exceed that minimum within reasonable tolerance limits. In complying with requirements, indicated or scheduled numeric values are either minimums or maximums as noted or as appropriate for the context of the requirements. Refer instances of uncertainty to Owner or Engineer via a request for information (RFI) for decision before proceeding.
- L. Abbreviations and Symbols: The language of Specifications and other Contract Documents including Drawings is of an abbreviated type in certain instances, and implies words and meanings which will be appropriately interpreted. Actual word abbreviations of a self explanatory nature have been included in text of Specifications and Drawings. Specific abbreviations and symbols have been established, principally for lengthy technical terminology and primarily in conjunction with coordination of Specification requirements with notations on Drawings and in Schedules. These are frequently defined in Section at first instance of use or on a Legend and Symbol Drawing. Trade and industry association names and titles of generally recognized industry standards are frequently abbreviated. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of Contract Documents so indicate. Except as otherwise indicated, graphic symbols and abbreviations used on Drawings and in Specifications are those recognized in construction industry for indicated purposes. Where not otherwise noted symbols and abbreviations are defined by 1993 ASHRAE Fundamentals Handbook, chapter 34 "Abbreviations and Symbols", ASME and ASPE published standards.

1.13 DRAWINGS AND SPECIFICATIONS

- A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.

- B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.
- C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.
- D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.
- E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution be made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date without fail.
- F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.
- G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.
- H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein.
- I. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) Design Documents and all other trades, including Division 26.
- J. Changes in architectural, structural, electrical, mechanical, and plumbing requirements for the substitution shall be the responsibility of the bidder wishing to make the substitution. This shall include the cost of redesign by the affected designer(s). Any additional cost incurred by affected subcontractors shall be the responsibility of this bidder and not the owner.
- K. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.

- L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions.
- M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

1.14 SUBMITTALS

- A. Coordinate with Division 1 for submittal timetable requirements, unless noted otherwise within thirty (30) days after the Contract is awarded the Contractor shall submit a minimum of eight (8) complete bound sets of shop drawings and complete data covering each item of equipment or material. The first submittal of each item requiring a submittal must be received by the Architect or Engineer within the above thirty day period. The Architect or Engineer shall not be responsible for any delays or costs incurred due to excessive shop drawing review time for submittals received after the thirty (30) day time limit. The Architect and Engineer will retain one (1) copy each of all shop drawings for their files. Where full size drawings are involved, submit one (1) print and one (1) reproducible sepia or mylar in lieu of eight (8) sets. All literature pertaining to an item subject to Shop Drawing submittal shall be submitted at one time. A submittal shall not contain information from more than one Specification section, but may have a section subdivided into items or equipment as listed in each section. The Contractor may elect to submit each item or type of equipment separately. Each submittal shall include the following items enclosed in a suitable binder:
 - 1. A cover sheet with the names and addresses of the Project, Architect, MEP Engineer, General Contractor and the Subcontractor making the submittal. The cover sheet shall also contain the section number covering the item or items submitted and the item nomenclature or description.
 - 2. An index page with a listing of all data included in the Submittal.
 - 3. A list of variations page with a listing all variations, including unfurnished or additional required accessories, items or other features, between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "NO VARIATIONS". Where variations affect the work of other Contractors, then the Contractor shall certify on this page that these variations have been fully coordinated with the affected Contractors and that all expenses associated with the variations will be paid by the submitting Contractor. This page will be signed by the submitting Contractor.
 - 4. Equipment information including manufacturer's name and designation, size, performance and capacity data as applicable. All applicable Listings, Labels, Approvals and Standards shall be clearly indicated.
 - 5. Dimensional data and scaled drawings as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances clearly indicated and labeled at a minimum scale of 1/4" = 1'-0", as required to demonstrate that the alternate or substituted product will fit in the space available.
 - 6. Identification of each item of material or equipment matching that indicated on the Drawings.
 - 7. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements or accessories shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method.

8. Additional information as required in other Sections of this Division.
 9. Certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Drawings and Specifications, signed and dated in long hand.
Submittals that do not comply with the above requirements shall be returned to the Contractor and shall be marked "REVISE AND RESUBMIT".
- B. Refer to Division 1 for additional information on shop drawings and submittals.
- C. Equipment and materials submittals and shop drawings will be reviewed for compliance with design concept only. It will be assumed that the submitting Contractor has verified that all items submitted can be installed in the space allotted. Review of shop drawings and submittals shall not be considered as a verification or guarantee of measurements or building conditions.
- D. Where shop drawings and submittals are marked "REVIEWED", the review of the submittal does not indicate that submittals have been checked in detail nor does it in any way relieve the Contractor from his responsibility to furnish material and perform work as required by the Contract Documents.
- E. Shop drawings shall be reviewed and returned to the Contractor with one of the following categories indicated:
1. REVIEWED: Contractor need take no further submittal action, shall include this submittal in the O&M manual and may order the equipment submitted on.
 2. REVIEWED AS NOTED: Contractor shall submit a letter verifying that required exceptions to the submittal have been received and complied with including additional accessories or coordination action as noted, and shall include this submittal and compliance letter in the O&M manual. The contractor may order the equipment submitted on at the time of the returned submittal providing the Contractor complies with the exceptions noted.
 3. NOT APPROVED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is not approved, the Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or drawings. Contractor shall not order equipment that is not approved. Repetitive requests for substitutions will not be considered.
 4. REVISE AND RESUBMIT: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked revise and resubmit, the Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or provide as noted on previous shop drawings. Contractor shall not order equipment marked revise and resubmit. Repetitive requests for substitutions will not be considered.
 5. CONTRACTOR'S CERTIFICATION REQUIRED: Contractor shall resubmit submittal on material, equipment or method of installation. The Contractor's stamp is required stating the submittal meets all conditions of the contract documents. The stamp shall be signed by the General Contractor. The submittal will not be reviewed if the stamp is not placed and signed on all shop drawings.
 6. MANUFACTURER NOT AS SPECIFIED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked manufacturer not as specified, the Contractor will automatically be required to furnish the product, material or method named in the specifications. Contractor shall not order equipment where submittal is marked manufacturer not as specified. Repetitive requests for substitutions will not be considered.
- F. Materials and equipment which are purchased or installed without shop drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Owner or Engineer for any

reason shall be at the expense of the Contractor. The responsible Contractor shall remove the material and equipment noted above and replace with specified equipment or material at his own expense when directed in writing by the Architect or Engineer.

- G. Shop Drawing Submittals shall be complete and checked prior to submission to the Engineer for review.
- H. Submittals are required for, but not limited to, the following items:
 - 1. Pipe Material and Specialties.
 - 2. Pipe Fabrication Drawings.
 - 3. Basic Materials.
 - 4. Variable Air Volume Boxes.
 - 5. Air Handling Units.
 - 6. Chillers.
 - 7. Water Treatment.
 - 8. Expansion Compensation.
 - 9. Variable Frequency Drives.
 - 10. Noise and Vibration Controls.
 - 11. HVAC Pipe and Duct Insulation.
 - 12. Hydronic Valves.
 - 13. Hydronic Piping and Accessories.
 - 14. Hydronic Pumps.
 - 15. Portable Pipe Hanger and Equipment Supports.
 - 16. Duct Specialties.
 - 17. Duct Fabrication Drawings.
 - 18. Air Distribution Devices.
 - 19. Fan Coil Units.
 - 20. Filters.
 - 21. Fans.
 - 22. Fire Dampers and Fire Smoke Dampers.
 - 23. Temperature Controls and Control Sequences.
 - 24. Test, Adjust and Balance Reports.
 - 25. Testing, Adjusting and Balancing Contractor Qualifications.
 - 26. Coordination Drawings.
- I. Refer to other Division 23 sections for additional shop drawing requirements. Provide samples of actual materials and/or equipment to be used on the Project upon request of the Owner or Engineer.

1.15 COORDINATION DRAWINGS

- A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. Indicate the proposed locations of pipe, duct, equipment, and other materials. Include the following:
 - a. Wall and type locations.
 - b. Clearances for installing and maintaining insulation.

- c. Locations of light fixtures and sprinkler heads.
 - d. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 - e. Equipment connections and support details.
 - f. Exterior wall and foundation penetrations.
 - g. Routing of storm and sanitary sewer piping.
 - h. Fire-rated wall and floor penetrations.
 - i. Sizes and location of required concrete pads and bases.
 - j. Valve stem movement.
 - k. Structural floor, wall and roof opening sizes and details.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 4. Prepare reflected ceiling plans to coordinate and integrate installations, air distribution devices, light fixtures, communication systems components, and other ceiling-mounted items.
- B. This Contractor shall be responsible for coordination of all items that will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.
- C. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

1.16 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 23, indicate the following installed conditions:
1. Duct mains and branches, size and location, for both exterior and interior; locations of dampers, fire dampers, duct access panels, and other control devices; filters, fuel fired heaters, fan coils, condensing units, and roof-top A/C units requiring periodic maintenance or repair.
 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 5. Contract Modifications, actual equipment and materials installed.
- B. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified herein to record the locations and invert elevations of underground installations.
- C. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes

made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.

- D. Refer to Division 1 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as-built prints and reproducibles is a condition of final acceptance.
- E. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.
- F. Submit three prints of the tracings for approval. Make corrections to tracings as directed and delivered "Auto Positive Tracings" to the architect. "As-Built" drawings shall be furnished in addition to shop drawings.
- G. When the option described in paragraph F., above is not exercised then upon completion of the work, the Contractor shall transfer all marks from the submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as follows:
 - 1. CERTIFIED RECORD DRAWINGS
 - 2. DATE:
 - 3. (NAME OF GENERAL CONTRACTOR)
 - 4. BY: _____
 - a. (SIGNATURE)
 - b. (NAME OF SUBCONTRACTOR)
 - c. BY: _____
 - 1) (SIGNATURE)

1.17 OPERATING MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 and in addition to the requirements specified in Division 1, include the following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.

1.18 CERTIFICATIONS AND TEST REPORTS

- A. Submit a detailed schedule for completion and testing of each system indicating scheduled dates for completion of system installation and outlining tests to be performed and schedule date for each test. This detailed completion and test schedule shall be submittal at least 90 days before the projected Project completion date.

- B. Test result reporting forms shall be submitted for review no later than the date of the detailed schedule submitted.
- C. Submit 4 copies of all certifications and test reports to the Architect or Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.
- D. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section of Division 23.

1.19 MAINTENANCE MANUALS

- A. Coordinate with Division 1 for maintenance manual requirements, unless noted otherwise bind together in "D ring type" binders by National model no. 79-883 or equal, binders shall be large enough to allow $\frac{1}{4}$ " of spare capacity. Three (3) sets of all approved shop drawing submittals, fabrication drawings, bulletins, maintenance instructions, operating instructions and parts exploded views and lists for each and every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference and shall utilize the individual specification section numbers shown in the Mechanical Specifications as an organization guideline. Bulletins containing information about equipment that is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 23 shall be clearly and legibly set forth in memoranda that shall, likewise, be bound with bulletins.
- B. Prepare maintenance manuals in accordance with Special Project Conditions, in addition to the requirements specified in Division 23, include the following information for equipment items:
 - 1. Identifying names, name tags designations and locations for all equipment.
 - 2. Valve tag lists with valve number, type, color coding, location and function.
 - 3. Reviewed shop drawing submittals with exceptions noted compliance letter.
 - 4. Fabrication drawings.
 - 5. Equipment and device bulletins and data sheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable, i.e., description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and model numbers of replacement parts.
 - 6. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 7. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions, servicing instructions and lubrication charts and schedules.
 - 8. Equipment and motor name plate data.
 - 9. Wiring diagrams.
 - 10. Exploded parts views and parts lists for all equipment and devices.
 - 11. Color coding charts for all painted equipment and conduit.
 - 12. Location and listing of all spare parts and special keys and tools furnished to the Owner.
 - 13. Furnish recommended lubrication schedule for all required lubrication points with listing of type and approximate amount of lubricant required.
- C. Refer to Division 1 for additional information on Operating and Maintenance Manuals.
- D. Operating and Maintenance Manuals shall be turned over to the Owner or Engineer a minimum of 14 working days prior to the beginning of the operator training period.

1.20 OPERATOR TRAINING

- A. The Contractor shall furnish the services of factory trained specialists to instruct the Owner's operating personnel. The Owner's operator training shall include 12 hours of on site training in three 4 hour shifts.
- B. Before proceeding with the instruction of Owner Personnel, prepare a typed outline in triplicate, listing the subjects that will be covered in this instruction, and submit the outline for review by the Owner. At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the reviewed outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
- C. Refer to other Division 23 Sections for additional Operator Training requirements.

1.21 FINAL COMPLETION

- A. At the completion of the work, all equipment and systems shall be tested and faulty equipment and material shall be repaired or replaced. Refer to Sections of Division 23 for additional requirements.
- B. Clean and adjust all air distribution devices and replace all air filters immediately prior to final acceptance.
- C. Touch up and/or refinish all scratched equipment and devices immediately prior to final acceptance.

1.22 CONTRACTOR'S GUARANTEE

- A. Use of the HVAC systems to provide temporary service during construction period will not be allowed without permission from the Owner in writing and if granted shall not be cause warranty period to start, except as defined below.
- B. Contractor shall guarantee to keep the entire installation in repair and perfect working order for a period of one year after its completion and final acceptance, and shall furnish free of additional cost to the Owner all materials and labor necessary to comply with the above guarantee throughout the year beginning from the date of issue of Substantial Completion, Beneficial Occupancy by the Owner or the Certificate of Final Payment as agreed upon by all parties.
- C. This guarantee shall not include cleaning or changing filters except as required by testing, adjusting and balancing.
- D. All air conditioning compressors shall have parts and labor guarantees for a period of not less than 5 years beyond the date of final acceptance.
- E. Refer to Sections in Division 23 for additional guarantee or warranty requirements.

1.23 TRANSFER OF ELECTRONIC FILES

- A. Project documents are not intended or represented to be suitable for reuse by Architect/Owner or others on extensions of this project or on any other project. Any such reuse or modification without written verification or adaptation by Engineer, as appropriate for the specific purpose intended, will be at Architect/Owner's risk and without liability or legal exposure to Engineer or its consultants from all claims, damages, losses and expense, including attorney's fees arising out of or resulting thereof.
- B. Because data stored in electric media format can deteriorate or be modified inadvertently, or otherwise without authorization of the data's creator, the party receiving the electronic files agrees that it will perform acceptance tests or procedures within sixty (60) days of receipt, after which time the receiving party shall be deemed to have accepted the data thus transferred to

be acceptable. Any errors detected within the sixty (60) day acceptance period will be corrected by the party delivering the electronic files. Engineer is not responsible for maintaining documents stored in electronic media format after acceptance by the Architect/Owner.

- C. When transferring documents in electronic media format, Engineer makes no representations as to the long term compatibility, usability or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by Engineer at the beginning of the Project.
- D. Any reuse or modifications will be Contractor's sole risk and without liability or legal exposure to Architect, Engineer or any consultant.
- E. The Texas Board of Architectural Examiners (TBAE) has stated that it is in violation of Texas law for persons other than the Architect of record to revise the Architectural drawings without the Architect's written consent.
 - 1. It is agreed that "MEP" hard copy or computer-generated documents will not be issued to any other party except directly to the Architect/Owner. The contract documents are contractually copyrighted and cannot be used for any other project or purpose except as specifically indicated in AIA B-141 Standard Form of Agreement Between Architect and Owner.
 - 2. If the client, Architect/Owner, or developer of the project requires electronic media for "record purposes", then an AutoCAD based compact disc ("CD") will be prepared. The "CD" will be submitted with all title block references intact and will be formatted in a "plot" format to permit the end user to only view and plot the drawings. Revisions will not be permitted in this configuration.
- F. At the Architect/Owner's request, Engineer will prepare one "CD" of electronic media to assist the contractor in the preparation of submittals. The Engineer will prepare and submit the "CD" to the Architect/Owner for distribution to the contractor. All copies of the "CD" will be reproduced for a cost of reproduction fee of Five Hundred Dollars (\$500.00) per "CD".
 - 1. The "CD" will be prepared and all title blocks, names and dates will be removed. The "CD" will be prepared in a ".dwg" format to permit the end user to revise the drawings.
- G. This Five Hundred Dollars (\$500.00) per "CD" cost of reproduction will be paid directly from the Contractor to the Engineer. The "CD" will be prepared only after receipt of the Five Hundred Dollars (\$500.00). The Five Hundred Dollars (\$500.00) per "CD" cost of reproduction is to only recover the cost of the manhours necessary to reproduce the documents. It is not a contractual agreement between the Contractor and Engineer to provide any engineering services, nor any other service.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide materials and equipment manufactured by a domestic United States manufacturer.
- B. Access Doors: Provide access doors as required for access to equipment, valves, controls, cleanouts and other apparatus where concealed. Access doors shall have concealed hinges and screw driver cam locks.
- C. All access panels located in wet areas such as restrooms, locker rooms, shower rooms, kitchen and any other wet areas shall be constructed of stainless steel.
- D. Access Doors: shall be as follows:
 - 1. Plastic Surfaces: Milcor Style K.
 - 2. Ceramic Tile Surface: Milcor Style M.
 - 3. Drywall Surfaces: Milcor Style DW.
 - 4. Install panels only in locations approved by the Architect.

PART 3 - EXECUTION

3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected via reviewed submittals.
- B. Refer to equipment specifications in Divisions 2 through 48 for additional rough-in requirements.

3.2 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - 8. Install systems, materials, and equipment to conform with architectural action markings on submittal, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, resolve conflicts and route proposed solution to the Architect for review.
 - 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 - 10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location and label.
 - 11. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified.
 - 12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
 - 13. Provide roof curbs for all roof mounted equipment. Coordinate with roof construction for pitched roof. Provide roof curb to match roof slope. Refer to architectural drawings and details.
 - 14. The equipment to be furnished under this Specification shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are

required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the product of the same manufacturer.

15. The architectural and structural features of the building and the space limitations shall be considered in selection of all equipment. No equipment shall be furnished which will not suit the arrangement and space limitations indicated.
16. Lubrication: Prior to start-up, check and properly lubricate all bearings as recommended by the manufacturer.
17. Where the word "Concealed" is used in these Specifications in connection with insulating, painting, piping, ducts, etc., it shall be understood to mean hidden from sight as in chases, furred spaces or suspended ceilings. "Exposed" shall be understood to mean the opposite of concealed.
18. Identification of Mechanical Equipment:
 - a. Mechanical equipment shall be identified by means of nameplates permanently attached to the equipment. Nameplates shall be engraved laminated plastic or etched metal. Shop drawings shall include dimensions and lettering format for approval. Attachments shall be with escutcheon pins, self-tapping screws, or machine screws.
 - b. Tags shall be attached to all valves, including control valves, with nonferrous chain. Tags shall be brass and at least 1-1/2 inches in diameter. Nameplate and tag symbols shall correspond to the identification symbols on the temperature control submittal and the "as-built" drawings.

3.3 CUTTING AND PATCHING

- A. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 1. Uncover Work to provide for installation of ill-timed Work.
 2. Remove and replace defective Work.
 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 4. Remove samples of installed Work as specified for testing.
 5. Install equipment and materials in existing structures.
 6. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer/Owner's observation of concealed Work, without additional cost to the Owner.
 7. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers; refer to the materials and methods required for the surface and building components being patched; Refer to Section "DEFINITIONS" for definition of "Installer."
- C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, mechanical ducts and HVAC units, and other mechanical items made obsolete by the new Work.
- D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.4 WORK SEQUENCE, TIMING, COORDINATION WITH OWNER

- A. The Owner will cooperate with the Contractor, however, the following provisions must be observed:

1. A meeting will be held at the project site, prior to any construction, between the Owner's Representative, the General Contractor, the Sub-Contractors and the Engineer to discuss Contractor's employee parking space, access, storage of equipment or materials, and use of the Owner's facilities or utilities. The Owner's decisions regarding such matters shall be final.
2. During the construction of this project, normal facility activities will continue in existing buildings until renovated areas are completed. Plumbing, fire protection, lighting, electrical, communications, heating, air conditioning, and ventilation systems will have to be maintained in service within the occupied spaces of the existing building.

3.5 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS

- A. In the preparation of these documents every effort has been made to show the approximate locations of, and connections to the existing piping, duct, equipment and other apparatus related to this phase of the work. However, this Contractor shall be responsible for verifying all of the above information. This Contractor shall visit the existing site to inspect the facilities and related areas. This Contractor shall inspect and verify all details and requirements of all the Contract Documents, prior to the submission of a proposal. All discrepancies between the Contract Documents and actual job-site conditions shall be resolved by his contractor, who shall produce drawings that shall be submitted to the Architect/Engineer for review. All labor and materials required to perform the work described shall be apart of this Contract.
- B. All equipment and/or systems noted on the Drawings "To Remain" shall be inspected and tested on site to certify its working condition. A written report on the condition of all equipment to remain, including a copy of the test results and recommended remedial actions and costs shall be made by this Contractor to the Architect/Engineer for review.
- C. All equipment and/or systems noted on the Drawings "To Be Removed" shall be removed including, associated pipe and duct pipe and duct hangers and/or line supports. Where duct or pipe is to be capped for future or end of line use, it shall be properly tagged with its function or service appropriately identified. Where existing equipment is to be removed or relocated and has an electric motor or connection, the Electrical Contractor shall disconnect motor or connection, remove wiring to a safe point and this Contractor shall remove or relocate motor or connection along with the equipment.
- D. During the construction and remodeling, portions of the Project shall remain in service. Construction equipment, material tools, extension cords, etc., shall be arranged so as to present minimum hazard or interruption to the occupants of the building. None of the construction work shall interfere with the proper operation of the existing facility or be so conducted as to cause harm or danger to persons on the premises. All fire exits, stairs or corridors required for proper access, circulation or exit shall remain clear of equipment, materials or debris. The General Contractor shall maintain barricades, other separations in corridors and other spaces where work is conducted.
- E. Certain work during the demolition phase of construction may require overtime or night time shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time at least seventy-two (72) hours in advance in writing.
- F. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.
- G. Equipment, piping or other potential hazards to the working occupants of the building shall not be left overnight outside of the designated working or construction area.
- H. Make every effort to minimize damage to the existing building and the owner's property. Repair, patch or replace as required any damage that might occur as a result of work at the

site. Care shall be taken to minimize interference with the Owner's activities during construction and to keep construction disrupted areas to a minimum. Corporate with the Owner and other trades in scheduling and performance of the work.

- I. Include in the contract price all rerouting of existing pipe, duct, etc., and the reconnecting of the existing equipment as necessitated by field conditions to allow the installation of the new systems regardless of whether or not such rerouting, reconnecting or relocating is shown on the drawings. Furnish all temporary pipe, duct, controls, etc., as required to maintain heating, cooling, and ventilation services for the existing areas with a minimum of interruption.
- J. All existing pipe, duct, materials, equipment, controls and appurtenances not included in the remodel or alteration areas are to remain in place.
- K. Pipe, duct, equipment and controls serving mechanical and owner's equipment, etc., which is to remain but which is served by pipe, duct, equipment and controls that are disturbed by the remodeling work, shall be reconnected in such a manner as to leave this equipment in proper operating condition.
- L. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and operating system in cooperation with other trades with a minimum of disruption or downtime.
- M. Refer to Architectural "Demolition and/or Alteration" plans for actual location of walls, ceiling, etc., being removed and/or remodeled.

END OF SECTION 230200

**SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- C. Operation Data: Include instructions for safe operating procedures.
- D. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.
- B. Time and Coordination: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
- C. Storage: Store materials in a clean, dry location, protected from weather and abuse.

1.7 WARRANTY

- A. Warrant the Work specified herein for one year and motors for five years beginning on the date of substantial completion against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.

PART 2 PRODUCTS

2.1 ELECTRIC MOTORS

- A. Approved Manufacturers: Provide motors by a single manufacturer as much as possible.
 - 1. Baldor
 - 2. Marathon
 - 3. Siemens-Allis
 - 4. General Electric
 - 5. MagneTek
 - 6. Reliance Electric/Rockwell Automation: www.reliance.com.
- B. Motor Requirements
 - 1. Phases and Current: Verify electrical service compatibility with motors to be used.
 - 2. Up to 1/2 HP: Provide permanent split, capacitor-start, 120/1/60 with inherent overload protection.
 - 3. 3/4 HP and Larger: Provide 480/3/60, with integral phase failure relay protection for all three pahes motors.
 - 4. All continuously operating motors shall be high efficiency design.
 - 5. All three phase motors located outside shall be TEFC type.
 - 6. Three phase motors located outside or where they may be subject to physical damage shall have cast iron enclosures.
 - 7. Motors serving condenser fans shall be totally enclosed (TEFC of TEAO) type. Steel enclosure is acceptable.
 - 8. Motors serving air handling units (mounted insidethe units) may be open drip proof type.
 - 9. Motors operating with variable frequency drives shall be specially designed for the application (invertor duty rating). All three phase motors shall have variable frequency drives.
 - 10. Motors shall be selected so they do not operate into the safety factor (non-overloading).
 - 11. Name plate voltage shall be the same as the circuit's normal voltage, serving the motor.
- C. Service Factor: 1.15 for polyphase; 1.35 for single phase.
- D. Frames: U-frames 1.5 hp. and larger.
- E. Bearings: Provide sealed re-greasable ball bearings; with top mounted zerc lubrication fittings and bottom side drains minimum average life 100,000 hours typically, and others as follows:
 - 1. Design for thrust where applicable.
 - 2. Permannately Sealed: Where not accessible for greasing.
 - 3. Sleeve-Type with Oil Cups: Light duty fractional hp. motors or polyphase requiring minimum noise level.
- F. Enclosure Type: Provide enclosures as follows:
 - 1. Concealed Indoor: Open drip proof.
 - 2. Exposed Indoor: Guarded.
 - 3. Outdoor Typical: Type II. TEC.
 - 4. Outdoor Weather Protected: Type I. TEA.
- G. Overload Protection: Built-in sensing device for stopping motor in all phase legs and signaling where indicated for fractional horse power motors.
- H. Noise Rating: "Quiet" except where otherwise indicated.
- I. Efficiency: Minimum full load efficiency listed in the following table, when tested in accordance with IEEE Test Procedure 112A, Method B, including stray load loss measure.

J. NEMA Efficiency

| 1. | Motor Horsepower | | INDEX Letter | Minimum Efficiency % |
|-----|----------------------------|---|--------------|----------------------|
| | 1800 RPM Synchronous Speed | | | |
| 1) | 7.5-10 | F | 89.5 | |
| 2) | 15-20 | E | | 91.0 |
| 3) | 25-30 | E | 92.4 | |
| 4) | 40 | D | 93.0 | |
| 5) | 50 | C | 93.0 | |
| 6) | 60 | C | 93.6 | |
| 7) | 75 | C | 94.1 | |
| 8) | 100-125 | B | 94.5 | |
| 9) | 150-200 | B | 95.0 | |
| | 1200 RPM Synchronous Speed | | | |
| 10) | 3-5 | G | 87.5 | |
| 11) | 7.5 | G | 89.5 | |
| 12) | 10 | F | 89.5 | |
| 13) | 15 | F | 90.2 | |
| 14) | 20 | E | 90.2 | |
| 15) | 25-30 | E | 91.7 | |
| 16) | 40-50 | D | 93.0 | |
| 17) | 60 | D | 93.6 | |
| 18) | 75 | C | 93.6 | |
| 19) | 100-125 | C | 94.1 | |
| 20) | 150-200 | B | 95.0 | |

PART 3 EXECUTION

3.1 INSTALLATION

- A. GENERAL: Install in a professional manner. Any part or parts not meeting this requirement shall be replaced or rebuilt without extra expense to Owner.
- B. Install rotating equipment in static and dynamic balance.
- C. Provide foundations, supports, and isolators properly adjusted to allow minimum vibration transmission within the building.
- D. Correct objectionable noise or vibration transmission in order to operate equipment satisfactorily as determined by the Engineer.

END OF SECTION

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**SECTION 23 0529
HANGERS AND SUPPORT FOR PIPING AND EQUIPMENT - HVAC****PART 1 - GENERAL****1.1 WORK INCLUDED**

- A. Pipe, and equipment hangers, supports, and associated anchors.
- B. Sleeves and seals.
- C. Flashing and sealing equipment and pipe stacks.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED WORK

- A. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Section 23 07 19 – HVAC Piping Insulation.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division One.
- B. Indicate hanger and support framing and attachment methods.

PART 2 - PRODUCTS**2.1 PIPE HANGERS AND SUPPORTS**

- A. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch Malleable iron, adjustable swivel, split ring.
- B. Hangers for Pipe Sizes 2 to 4 Inches Carbon steel, adjustable, clevis.
- C. Hangers for Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for pipe sizes 6 inches and over.
- E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- F. Wall Support for Pipe Sizes 4 Inches and Over: adjustable steel yoke and cast iron roll.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- I. Floor Support for Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- J. Roof Pipe Supports and Hangers: Galvanized Steel Channel System as manufactured by Portable Pipe Hangers, Inc. or approved equal.
 - 1. For pipes 2-1/2" and smaller – Type PP10 with roller
 - 2. For pipes 3" through 8" – Type PS
 - 3. For multiple pipes – Type PSE - Custom

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- K. Copper Pipe Support and Hangers: Electro-galvanized with thermoplastic elastomer cushions; Unistrut "Cush-A-Clamp" or equal. Hangers: Plastic coated; Unistrut or equal.
- L. For installation of protective shields refer to specification section 22 05 29 - 3.03.
- M. Shields for Vertical Copper Pipe Risers: Sheet lead.
- N. Pipe Rough-In Supports in Walls/Chases: Provide preformed plastic pipe supports, Sioux Chief "Pipe Titan" or equal.

2.2 HANGER RODS

- A. Galvanized Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.3 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

- A. Metal Flashing: 20 gage galvanized steel.
- B. Lead Flashing: 4 lb./sq. ft. sheet lead for waterproofing; 1 lb./sq. ft. sheet lead for soundproofing.
- C. Caps: Steel, 20 gage minimum; 16 gage at fire resistant elements.
- D. Coordinate with roofing contractor/architect for type of flashing on metal roofs.

2.5 EQUIPMENT CURBS

- A. Fabricate curbs of hot dipped galvanized steel.

2.6 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel, tack welded to form a uniform sleeve.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Form with steel pipe, schedule 40.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated steel sleeves including seals, UL listed.
- D. Sleeves for Round Ductwork: Form with galvanized steel.
- E. Sleeves for Rectangular Ductwork: Form with galvanized steel.
- F. Fire Stopping Insulation: Glass fiber type, non-combustible, U.L. listed.
- G. Caulk: Paintable 25-year acrylic sealant.
- H. Pipe Alignment Guides: Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted, two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

2.7 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported pipe.
- C. Design roof supports without roof penetrations, flashing or damage to the roofing material.

2.8 FINISH

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- A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 INSERTS

- A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams. Coordinate with structural engineer for placement of inserts.
- B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- C. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.
- D. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. Verify with structural engineer prior to start of work.

3.2 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as follows:

| 1. PIPE SIZE | MAX. HANGER SPACING | HANGER DIAMETER |
|------------------------|---------------------|-----------------|
| 2. (Copper Pipe) | | |
| 3. 1/2 to 1-1/4 inch | 5'-0" | 3/8" |
| 4. 1-1/2 to 2-1/2 inch | 8'-0" | 3/8" |
| 5. 3 to 4 inch | 10'-0" | 3/8" |
| 6. 6 to 8 inch | 10'-0" | 1/2" |
| 7. (PVC Pipe) | | |
| 8. 1-1/2 to 4 inch | 4'-0" | 3/8" |
| 9. 6 to 8 inch | 4'-0" | 1/2" |
| 10. 10 and over | 4'-0" | 5/8" |

- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place a hanger within 12 inches of each horizontal elbow and at the vertical horizontal transition.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Install hangers with nut at base and above hanger; tighten upper nut to hanger after final installation adjustments.
- J. Portable pipe hanger systems shall be installed per manufactures instructions.

3.3 INSULATED PIPING: COMPLY WITH THE FOLLOWING INSTALLATION REQUIREMENTS.

- A. Clamps: Attach galvanized clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
- B. Saddles: Install galvanized protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

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- C. Shields: Install protective shields MSS Type 40 on cold and chilled water piping that has vapor barrier. Shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:
- | 1. | LENGTH | THICKNESS | | |
|----|-------------------|-----------|-------|--|
| 2. | 1/4 THROUGH 3-1/2 | 12 | 0.048 | |
| 3. | 12 | 0.060 | | |
| 4. | 18 | 0.060 | | |
| 5. | 8 THROUGH 14 | 24 | 0.075 | |
| 6. | 16 THROUGH 24 | 24 | 0.105 | |
7. Piping 2" and larger provide galvanized sheet metal shields with calcium silicate at hangers/supports.
8. Insert material shall be at least as long as the protective shield.
9. Thermal Hanger Shields: Install where indicated, with insulation of same thickness as piping.

3.4 EQUIPMENT BASES AND SUPPORTS

- A. Provide equipment bases of concrete.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct support of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 FLASHING

- A. Provide flexible flashing and metal counter flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 8 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter flash and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor shower mop sink and all other drains watertight to adjacent materials.
- E. Provide curbs for mechanical roof installations 8 inches minimum high above roofing surface. Contact architect for all flashing details and roof construction. Seal penetrations watertight.

3.6 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Extend sleeves through floors minimum one inch above finished floor level. Caulk sleeves full depth with fire rated thermfiber and 3M caulking and provide floor plate.
- C. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with U.L. listed fire stopping insulation and caulk seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- D. Fire protection sleeves may be flush with floor of stairways.

END OF SECTION 230529

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SECTION 23 0548

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Vibration and sound control products.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract including General and Supplementary Conditions and Division One specification sections, apply to work of this section
- B. This section is Division-23 Basic Materials and Methods section, and is part of each Division-23 section making reference to vibration control products specified herein.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Vibration and sound control products shall conform to ASHRAE criteria for average noise criteria curves for all equipment at full load conditions.
- C. Except as otherwise indicated, sound and vibration control products shall be provided by a single manufacturer.

1.5 SUBMITTALS

- A. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Amber/Booth Company, Inc.
- B. Mason Industries, Inc.
- C. Noise Control, Inc.

2.2 GENERAL

- A. Provide vibration isolation supports for equipment, piping and ductwork, to prevent transmission of vibration and noise to the building structures that may cause discomfort to the occupants.
- B. Model numbers of Amber/Booth products are included for identification. Products of the additional manufacturers will be acceptable provided they comply with all of the requirements of

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this specification.

2.3 FLOOR MOUNTED AIR HANDLING UNITS

- A. Provide Amber/Booth XLW-2, style C aluminum housed isolators sized for 2" static deflection. Cast iron or steel housings may be used provided they are hot-dip galvanized after fabrication
- B. If floor mounted air handling units are furnished with internal vibration isolation option, provide 2" thick Amber/Booth type NRC ribbed neoprene pads to address high frequency breakout and afford additional unit elevation for condensate drains. Ribbed neoprene pads shall be located in accordance with the air handling unit manufacturer's recommendations.

2.4 SUSPENDED AIR HANDLING UNITS

- A. Provide Amber/Booth type BSWR-2 combination spring and rubber-in-shear isolation hanger sized for 2" static deflection.
- B. If suspended air handling units are furnished with internal vibration isolation option, furnish Amber/Booth type BRD rubber-in-shear or NR AMPAD 3/8" thick neoprene pad isolation hangers sized for approximately 1/2" deflection to address high frequency break-out.

2.5 SUSPENDED FANS AND FAN COIL UNITS

- A. Provide Amber/Booth type BSS spring hangers sized for 1" static deflection.

2.6 PIPING

- A. Provide spring and rubber-in-shear hangers, Amber/Booth type BSR in mechanical equipment rooms, for a minimum distance of 50 feet from isolated equipment for all chilled water and hot water piping 1-1/2" diameter and larger. Springs shall be sized for 1" deflection.
- B. Floor supported piping is required to be isolated with Amber/Booth type SW-1 open springs sized for 1" deflection.
- C. Furnish line size flexible connectors at supply and return of pumps, amber/booth style 2800 single sphere EPDM construction, connector shall include 150 lb. cadmium plated carbon steel floating flanges.

2.7 CORROSION PROTECTION

- A. All vibration isolators shall be designed and treated for resistance to corrosion.
- B. Steel components: PVC coated or phosphated and painted with industrial grade enamel. Nuts, bolts, and washers: zinc-electroplated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed in accordance with the manufacturers recommendations and printed installation instructions.
- B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.
- C. If internal isolation option is used on air handling units, the mechanical contractor shall verify proper adjustment and operation of isolators prior to start-up. All shipping brackets and temporary restraint devices shall be removed.
- D. The vibration isolation supplier shall certify in writing that he has inspected the installation and that all external isolation materials and devices are installed correctly and functioning properly.

END OF SECTION 230548

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**SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 23 02 00, are included as a part of this Section as though written in full in this document.

1.2 SCOPE

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

1.3 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 REFER TO ARCHITECTURAL SECTIONS FOR ADDITIONAL REQUIREMENTS.**PART 2 - PRODUCTS****2.1 VALVE AND PIPE IDENTIFICATION**

- A. Valves:
 - 1. All valves shall be identified with a 1-1/2" diameter brass disc wired onto the handle. The disc shall be stamped with 1/2" high depressed black filled identifying numbers. These numbers shall be numerically sequenced for all valves on the job.
 - 2. The number and description indicating make, size, model number and service of each valve shall be listed in proper operational sequence, properly typewritten. Three copies to be turned over to Owner at completion.
 - 3. Tags shall be fastened with approved meter seal and 4 ply 0.018 smooth copper wire. Tags and fastenings shall be manufactured by the Seton Name Plate Company or approved equal.
 - 4. All valves shall be numbered serially with all valves of any one system and/or trade grouped together.
- B. Pipe Marking:
 - 1. All interior visible piping located in accessible spaces such as above accessible ceilings, equipment rooms, attic space, under floor spaces, etc., shall be identified with all temperature pipe markers as manufactured by W.H. Brady Company, 431 West Rock Ave., New Haven, Connecticut, or approved equal.
 - 2. All exterior visible piping shall be identified with UV and acid resistant outdoor grade acrylic plastic markers as manufactured by Set Mark distributed by Seton nameplate

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company. Factory location 20 Thompson Road, Branford, Connecticut, or approved equal.

3. Generally, markers shall be located on each side of each partition, on each side of each tee, on each side of each valve and/or valve group, on each side of each piece of equipment, and, for straight runs, at equally spaced intervals not to exceed 75 feet. In congested area, marks shall be placed on each pipe at the points where it enters and leaves the area and at the point of connection of each piece of equipment and automatic control valve. All markers shall have directional arrows.
4. Markers shall be installed after final painting of all piping and equipment and in such a manner that they are visible from the normal maintenance position. Manufacturer's installation instructions shall be closely followed.
5. Markers shall be colored as indicated below per ANSI/OSHA Standards:
 - a. SYSTEM COLOR LEGEND
 - b. Sanitary Sewer Green Vent
 - 1) Sanitary Sewer
 - c. Storm Drain Green Storm Drain
 - d. Domestic Water Green Domestic Water
 - e. Domestic Hot Water Yellow Domestic Hot
 - f. Supply Water Supply
 - g. Domestic Hot Water Yellow Domestic Hot
 - h. Recirculating Water Return
 - i. Fire Protection Red Fire Protection
 - j. Automatic Red Fire
 - k. Sprinkler Sprinkler
 - l. Yellow Natural Gas
 - m. Condenser Water Green Condenser Water Supply
 - 1) Condenser Water Return
 - n. Compressed Air Blue Compressed Air

C. Pipe Painting:

1. All piping exposed to view shall be painted as indicated or as directed by the Architect in the field. Confirm all color selections with Architect prior to installation.
2. The entire fire protection piping system shall be painted red.
3. All piping located in mechanical rooms and exterior piping shall be painted as indicated below:
 - a. System Color
 - b. Storm Sewer White
 - c. Sanitary Sewer Waste and Vent Light Gray
 - d. Domestic Cold Water Dark Blue
 - e. Domestic Hot Water Supply and Return Orange
 - f. Heating Hot Water Supply and Return Reddish Orange

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All labeling equipment shall be installed as per manufacturers printed installation instructions.
- B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Contractors price shall include all items required as per manufacturers' requirements.

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- C. All piping shall be cleaned of rust, dirt, oil, and all other contaminants prior to painting. Install primer and a quality latex paint over all surfaces of the pipe.

END OF SECTION 230553

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SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 23 02 00, are included as a part of this Section as though written in full in this document.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED DOCUMENTS

- A. Approved submittal date on equipment installed, to accomplish the test procedures, outlined under Services of the Contractor of this Section, will be provided by the Contractor.

1.4 DESCRIPTION

- A. The TAB of the air conditioning systems will be performed by an impartial technical firm whose operations are limited only to the field of professional TAB. The TAB work will be done under the direct supervision of a qualified engineer employed by the TAB firm.
- B. The TAB firm will be responsible for inspecting, adjusting, balancing, and logging the date on the performance of fans, dampers in the duct system, and air distribution devices. The Contractor and the various subcontractors of the equipment installed shall cooperate with the TAB firm to furnish necessary data on the design and proper applications of the system components and provide labor and material required to eliminate deficiencies or malperformance.

1.5 QUALITY ASSURANCE

- A. **QUALIFICATIONS OF CONTRACTOR PERSONNEL:** Submit evidence to show that the personnel who shall be in charge of correcting deficiencies for balancing the systems are qualified. The Owner and Engineer reserve the right to require that the originally approved personnel be replaced with other qualified personnel if, in the Owner and Engineer's opinion, the original personnel are not qualified to properly place the system in condition for balancing.
- B. **QUALIFICATIONS OF TAB FIRM PERSONNEL:**
 - 1. A minimum of one registered Professional Engineer licensed in the State, is required to be in permanent employment of the firm.
 - 2. Personnel used on the jobsite shall be either Professional Engineers or technicians, who shall have been permanent, full time employees of the firm for a minimum of six months prior to the start of Work for that specified project.

3. Evidence shall be submitted to show that the personnel who actually balance the systems are qualified. Evidence showing that the personnel have passed the tests required by the Associated Air Balance Council (AABC) shall be required.
- C. CALIBRATION LIST: Submit to the Engineer for approval, a list of the gauges, thermometers, velometer, and other balancing devices to be used in balancing the system. Submit evidence to show that the balancing devices are properly calibrated before proceeding with system balancing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SERVICES OF THE CONTRACTOR

- A. The Drawings and specifications have indicated valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, install these devices in a manner that leaves them accessible, provide access as requested by the TAB firm.
- B. Have systems complete and in operational readiness prior to notifying the TAB firm that the project is ready for their services, and certify in writing to the Construction Manager that such a condition exists.
- C. As a part of the Work of this Section, make changes in the sheaves, belts, and dampers or the addition of dampers required for correct balance of the new work as required by the TAB firm, at no additional cost to the Owner.
- D. Fully examine the existing system to be balanced, to determine whether or not sufficient volume dampers, balancing valves, thermometers, gauges, pressure and temperature taps, means of reading static pressure and total pressure in duct systems, means of determining water flow, and other means of taking data needed for proper water and air balancing are existing. Submit to the Engineer in writing a listing of omitted items considered necessary to balance existing systems. Submit the list and proposal as a cost add item.
- E. Verify that fresh air louvers are free of blockage, coils are clean and fresh air ducts to each air handling unit has individually adjustable volume regulating dampers.
- F. Provide, correct, repair, or replace deficient items or conditions found during the testing, adjusting, and balancing period.
- G. In order that systems may be properly tested, balanced, and adjusted as specified, operate the systems at no expense to the Owner for the length of time necessary to properly verify their completion and readiness for TAB period.
- H. Project Contract completion schedules shall provide time for allowances to permit the successful completion of TAB services to Owner's final inspection and acceptance. Complete, operational readiness, prior to commencement of TAB services, shall include the following services of the Contractor:
 1. Construction status of building shall permit the closing of doors, window, ceilings installed and penetrations complete, to obtain project operating conditions.
 2. AIR DISTRIBUTION SYSTEMS:
 - a. Verify installation for conformity to design. Supply, return, and exhaust ducts terminated and pressure tested for leakage as specified.
 - b. Volume and fire dampers properly located and functional. Dampers serving requirements of minimum and maximum outside air, return and relief shall provide tight closure and full opening, smooth and free operation.
 - c. Supply, return, exhaust and transfer grilles, registers and diffusers.

- d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and sealed to eliminate excessive bypass or leakage of air.
 - e. Fans (supply and exhaust) operating and verified for freedom from vibrations, proper fan rotation and belt tension; overload heater elements shall be of proper size and rating; record motor amperage and voltage and verify that these functions do not exceed nameplate ratings.
 - f. Furnish or revise fan drives or motors as necessary to attain the specified air volumes.
3. AUTOMATIC CONTROLS:
- a. Verify that control components are installed in accordance with project documents and functional, electrical interlocks, damper sequences, air and water resets, fire and freeze stats.
 - b. Controlling instruments shall be functional and set for design operating conditions. Factory precalibration of room thermostats and pneumatic equipment will not be acceptable.
 - c. The temperature regulation shall be adjusted for proper relationship between the controlling instruments and calibrated by the TAB Contractor. Advise Owner of deficiencies or malfunctions.

3.2 SERVICES OF THE TAB FIRM

- A. The TAB firm will act as liaison between the Owner, Engineer, and the Contractor and inspect the installation of mechanical piping system, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems being retrofitted, repaired, or added under this Contract. The reinspection of the Work will cover that part related to proper arrangement and adequate provision for the testing and balancing and will be done when the Work is 80 percent complete.
- B. Upon completion of the installation and start-up of the mechanical equipment, to check, adjust, and balance system components to obtain optimum conditions in each conditioned space in the building. Prepare and submit to the Owner complete reports on the balance and operations of the systems.
- C. Measurements and recorded readings of air, water, and electricity that appear in the reports will be done by the permanently employed technicians or engineers of the TAB firm.
- D. Make an inspection in the building during the opposite season from that in which the initial adjustments were made. At the time, make necessary modifications to the initial adjustments required to produce optimum operation of system components to affect the proper conditions as indicated on the Drawings. At time of opposite season check-out, the Owner's representative will be notified before readings or adjustments are made.
- E. In fan systems, the air quantities indicated on the Drawings may be varied as required to secure a maximum temperature variation of two degrees within each separately controlled space, but the total air quantity indicated for each zone must be obtained. It shall be the obligation of the Contractor to furnish or revise fan drive and motors if necessary, without cost to the Owner, to attain the specified air volumes.
- F. The various existing water circulating systems shall be cleaned, filled, purged of air, and put into operation before hydronic balancing.

3.3 PROFESSIONAL REPORT

- A. Before the final acceptance of the report is made, the TAB firm will furnish the Owner the following data to be approved by the Owner and Engineer:

1. Summary of main supply, return and exhaust duct pitot tube traverses and fan settings indicating minimum value required to achieve specified air volumes.
2. A listing of the measured air quantities at each outlet corresponding to the temperature tabulation as developed by the Engineer and TAB firm.
3. Air quantities at each return and exhaust air handling device.
4. Static pressure readings entering and leaving each supply fan, exhaust fan, filter, coil, balancing dampers and other components of the systems included in the retrofit Work. These readings will be related to performance curves in terms of the CFM handled if available.
5. Motor current readings at each equipment motor on load side of capacitors. The voltages at the time of the reading shall be listed.
6. The final report shall certify test methods and instrumentation used, final velocity reading obtained, temperatures, pressure drops, RPM of equipment, amperage of motors, air balancing problems encountered, recommendations and uncompleted punch list items. The test results will be recorded on standard forms.
7. A summary of actual operating conditions shall be included with each system outlining normal and ventilation cycles of operation. the final report will act as a reference of actual operating conditions for the Owner's operating personnel.

3.4 BALANCING AIR CONDITIONING SYSTEM

A. GENERAL:

1. Place all equipment into full operation, and shall continue the operating during each working day of balancing and testing. If the air conditioning system is balanced during Off-Peak cooling season Balancing Contractor shall return to rebalance air side system as required to put system in proper balance at that time.
2. The Contractor shall submit detailed balancing and recording forms for approval. After the approval by the Architect, prepare complete set of forms for recording test data on each system. All Work shall be done under the supervision of a Registered Professional Engineer. All instruments used shall be accurately calibrated to within 1% of scale and maintained in good working order.
3. Upon completion of the balancing and testing, the Balancing Contractor shall compile the test data in report forms, and forward five copies to the Architect for evaluation.
4. The final report shall contain logged results of all tests, including such data as:
 - a. Tabulation of air volume at each outlet.
 - b. Outside dry bulb and wet bulb temperature.
 - c. Inside dry bulb and wet bulb temperatures in each conditioned space room or area.
 - d. Actual fan capacities and static pressures. Motor current and voltage readings at each fan.

B. AIR SYSTEMS: Perform the following operations as applicable to system balance and test:

1. Check fan rotation.
2. Check filters (balancing shall be done with clean filters).
3. Test and adjust blower rpm to design requirements.
4. Test and record motor full load amperes.
5. Test and record system static pressures, suction and discharge.
6. Test and adjust system for design cfm, return air and outside air (+2%). Change-out fan sheaves as required to balance system.
7. Test and record entering air temperatures, db and wb.
8. Test and record leaving air temperatures, db and wb.

9. Adjust all zones to design cfm (+2%).
 10. Test and adjust each diffuser, grille, and register to within 5% of design.
- C. AIR DUCT LEAKAGE: (From SMACNA Duct Standards 3rd Edition) Test all ductwork (designed to handle over 1000 CFM) as follows:
1. Test apparatus
 - a. The test apparatus shall consist of:
 - b. A source of high pressure air--a portable rotary blower or a tank type vacuum cleaner.
 - c. A flow measuring device consisting of straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly shall be accurately calibrated with its own calibration curve. Pressure and flow readings shall be taken with U-tube manometers.
 2. Test Procedures
 - a. Test for audible leaks as follows:
 - 1) Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
 - 2) Start the blower with its control damper closed.
 - 3) Gradually open the inlet damper until the duct pressure reaches 1.2 times the standard designed duct operating pressure.
 - 4) Survey all joint for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.
 - b. After all audible leaks have been sealed, the remaining leakage should be measured with the orifice section of the test apparatus as follows:
 - 1) Start blower and open damper until pressure in duct reaches 25% in excess of designed duct operating pressure.
 - 2) Read the pressure differential across the orifice on manometer No. 2. If there is no leakage, the pressure differential will be zero.
 - 3) Total allowable leakage shall not exceed one (1) percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
 - 4) Even though a system may pass the measured leakage test, a concentration of leakage at one point may result in a noisy leak which, must be corrected.
- D. DX SYSTEMS:
1. Test and record suction and discharge pressures at each compressor and record ambient air temperature entering the condensing coils.
 2. Test and record unit full load amps and voltage.
 3. Test and record staging and unloading of unit required by sequence of operation or drawing schedule.
- E. Automatic temperature controls shall be calibrated and all thermostats and dampers, adjusted so that the control system is in proper operating condition, subject to the approval of the Architect.
- F. The Air Balance Contractor shall report to Engineer all air distribution devices or other equipment that operate noisily so that corrective measures may be implemented by the Contractor at no additional cost to the Owner or Architect/Engineer.

END OF SECTION 230593

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**SECTION 23 0713
DUCT INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.
- E. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2014.
- F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2012.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

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

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. Johns Manville; _____: www.jm.com/#sle.
 - 2. Owens Corning Corporation; _____: www.ocbuildingspec.com/#sle.
- B. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure sensitive tape.

2.3 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. Johns Manville; _____: www.jm.com/#sle.
 - 2. Owens Corning Corp: www.owenscorning.com.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent.
 - 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.

2.4 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 1. Lagging Adhesive:
 - a. Manufacturers:

- 1) Minnesota Mining
 - 2) Arabol
 - 3) Armstrong
- B. Aluminum Jacket: ASTM B209 (ASTM B209M).
1. Thickness: 0.016 inch x 36 inch sheet with moisture barrier.
 2. Finish: Smooth.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 5. Aluminum fasteners: 0.75 inch bands, 0.75 inch wing seals, 0.024 elbow covers.
 6. Screws are not to be used to secure jacketing.
- C. Stainless Steel Jacket - Type 304 (High Traffic Area): ASTM B209 (ASTM B209M).
1. Thickness: 0.020 inch x 36 inch sheet with moisture barrier.
 2. Finish: Smooth.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Fittings: 0.020 inch thick die shaped fitting covers with factory attached protective liner.
 5. Type 304 stainless steel fasteners: 0.50 inch x 0.020 bands, 0.50 inch wing seals.
 6. Screws are not to be used to secure jacketing.

2.5 DUCT LINER

- A. Manufacturers:
1. Johns Manville; _____: www.jm.com/#sle.
 2. Owens Corning Corporation: www.ocbuildingspec.com.
- B. Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket and rigid board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
1. Fungal Resistance: No growth when tested according to ASTM G21.
 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 3. Service Temperature: Up to 250 degrees F.
 4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad or impact applied with integral head.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Allow adequate clearance in plenum to ensure duct insulation is not compressed.
- C. Provide 2 hour enclosure on grease exhaust duct. Enclosure shall extend from kitchen hood to underside of roof deck.
- D. Insulate all supply, return fresh air, outside air, make-up air and exhaust ducts.
- E. Insulated Ducts Conveying Air Below Ambient Temperature:
- F. Insulated Ducts Conveying Air Above Ambient Temperature:
- G. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

- H. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.
- I. Duct and Plenum Liner Application:
 - 1. Adhere insulation with adhesive for 90 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 - 3. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.

END OF SECTION

**SECTION 23 3100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low Pressure Ductwork
- B. Nonmetal ductwork.
- C. Casing and plenums.
- D. Kitchen hood ductwork.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 09 9113 - Exterior Painting: Weld priming, weather resistant, paint or coating.
- B. Section 23 0200 Basic Materials and Methods
- C. Section 23 0529 Hangers and Support for Piping and Equipment HVAC
- D. Section 23 0713 - Duct Insulation: External insulation and duct liner.
- E. Section 23 3300 - Air Duct Accessories.
- F. Section 23 3700 - Air Outlets and Inlets.

1.4 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2015.
- D. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2014.
- E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- F. SMACNA (FGD) - Fibrous Glass Duct Construction Standards; 2003.
- G. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines; 2001.
- H. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

1.5 GENERAL DESCRIPTION

- A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

1.6 SUBMITTALS

- A. Product Data: Provide data for duct materials.
- B. Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work.
- C. The contract documents are schematic in nature and are to be used only for design intent. The contractor shall prepare sheet metal shop drawings, fully detailed and drawn to scale, indicating all structural conditions, all plumbing pipe and light fixture coordination, and all offsets and transitions as required to permit the duct to fit in the space allocated and built. All duct revisions required as a result of the contractor not preparing fully detailed shop drawings will be performed at no additional cost.
- D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.7 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain indicated clear size inside lining. Where offsets or transitions are required, the duct shall be the equivalent size based on constant friction rate.
- B. Low Pressure: Low pressure ductwork shall be rated for an operating pressure of 2". Low pressure ductwork shall be defined as all return, exhaust, and outside air ducts, all supply ductwork associated with constant volume air handling units with a scheduled external static pressure of less than 2", and all supply ductwork downstream of terminal units in variable volume systems.
- C. Medium Pressure: Medium pressure ductwork shall be rated for an operating pressure of 4". Medium pressure ductwork shall be defined as all supply ductwork extending from variable volume air handling units to terminal units in variable volume systems with air handling units having a scheduled external static pressure of less than 4". The supply ductwork of constant volume air handling units having a scheduled external static pressure greater than 2" and less than 4" shall be rated for medium pressure.
- D. High Pressure: High pressure ductwork shall be rated for an operating pressure of 6", or the scheduled external pressure of the equipment it is connected to, whichever is greater. The supply ductwork of air handling units having a scheduled external static pressure greater than 4" shall be high pressure.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings, use sheet metal end caps on any lined duct exposed to the weather.
- B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

1.9 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.
- B. Sheet Metal.: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality, with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.
- C. Stainless Steel Sheet: Where indicated, provide stainless steel complying with ASTM A167; Type 316; with No. 4 finish where exposed to view in occupied spaces, No. 1 finish elsewhere. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.
- D. Aluminum Sheet: Where indicated, provide aluminum sheet complying with ASTM B 209, Alloy 3003, Temper H14.
- E. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
- F. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Non combustible and conforming to UL 181, Class 1 air duct materials.
- B. Flexible Ducts: Flexmaster U.S.A., Inc. Type 3M or approved equal, corrosive resistant galvanized steel formed and mechanically locked to inner fabric with 1" thick insulation when flexible ducts are located in conditioned spaces and with R-5 insulation when located in unconditioned spaces. Flexible duct shall have reinforced metalized outer jacket with poly inner liner and comply with UL 181, Class 1 air duct. Foil inner liner is not acceptable.
- C. Sealants: Hard-Cast "iron grip" or approved equal, non-hardening, water resistant, fire resistive and shall not be a solvent curing product. Sealants shall be compatible with mating materials, liquid used alone or with tape or heavy mastic.
- D. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - 1. For exposed stainless steel ductwork, provide matching stainless steel support materials.
 - 2. For aluminum ductwork, provide aluminum support materials.

2.3 LOW PRESSURE DUCTWORK

- A. Fabricate and support in accordance with latest SMACNA Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by approved shop drawings. Obtain engineer's approval prior to using round duct in lieu of rectangular duct.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide airfoil-turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- E. Use crimp joints with bead for joining round duct sizes 6 inch smaller with crimp in direction of airflow.
- F. Use double nuts and lock washers on threaded rod supports.

2.4 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.5 MANUFACTURED DUCTWORK AND FITTINGS

- A. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
 - 1. Maximum Velocity: 4000 fpm.
 - 2. Temperature Range: Minus 20 degrees F to 175 degrees F.
- B. Kitchen Cooking Hood and Grease Exhaust: Nominal 3 inches thick ceramic fiber insulation between 20 gage, 0.0375 inch, Type 304 stainless steel liner and 24 gage, 0.0239 inch aluminized steel sheet outer jacket.
 - 1. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
 - 2. Certified for zero clearance to combustible material in accordance with:
 - 3. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:

2.6 CASINGS

- A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gage, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gage, 0.0598 inch sheet steel back facing and 22 gage, 0.0299 inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb/cu ft minimum glass fiber insulation media, on inverted channels of 16 gage, 0.0598 inch sheet steel.

2.7 FIBROUS GLASS DUCTS

- A. Fibrous Glass Ducts: 1 inch thick rigid glass fiber with aluminum foil, glass scrim and Kraft or plastic jacket vapor barrier; maximum 0.23 K value at 75 degrees F.
- B. Fabricate in accordance with SMACNA (FGD), except as indicated.
- C. Machine fabricate fibrous glass ducts and fittings. Make only minor on site manual adjustments.

- D. Do not use fibrous glass ducts within 12 inches of electric or fuel fired heaters.

2.8 COMMERCIAL DRYER VENT

- A. Construct of 18 gauge, Type 316 stainless steel.
- B. All welded construction.
- C. Provide hard duct connection to dryer.

2.9 KITCHEN HOOD EXHAUST DUCTWORK

- A. Fabricate in accordance with ductwork manufacturer's installation instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.
- B. B. Construct of 16 gauge carbon steel or 18 gauge stainless steel, using continuous external welded joints.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Flexible Ducts: Connect to metal ducts with adhesive.
- E. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- F. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- G. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. Connect terminal units to supply ducts with two foot minimum length of flexible duct. Do not use flexible duct to change direction.
- J. Connect diffusers or light troffer boots to low pressure ducts directly or with 6 feet maximum length of flexible duct held in place with strap or clamp.
- K. At exterior wall louvers, seal duct to louver frame and install blank-out panels as required.

3.2 INSTALLATION OF FLEXIBLE DUCTS

- A. Maximum Length: For any duct run using flexible ductwork, do not exceed 6'-0" extended length.
- B. Installation: Install in accordance with Section III of SMACNA's, "HVAC Duct Construction Standards, Metal and Flexible".

3.3 REQUIREMENTS FOR UNIT CASINGS

- A. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

3.4 REQUIREMENTS FOR KITCHEN HOOD EXHAUST DUCT

- A. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout.

- B. Provide access openings in each change in direction, located on sides of duct 1½" minimum from bottom, and fitted with grease-tight covers of same material as duct
- C. Use stainless steel for ductwork exposed to view.

3.5 DUCTWORK APPLICATION SCHEDULE

| <u>AIR SYSTEM</u> | <u>MATERIAL</u> |
|---|-----------------------------------|
| Low Pressure Supply | Steel, Aluminum |
| Medium and High Pressure Supply | Steel |
| Return and Relief | Steel, Aluminum |
| General Exhaust | Steel, Aluminum |
| Kitchen Hood Exhaust | Galvanized Steel, Stainless Steel |
| Dishwasher/Shower/Locker Room/ Dryer Vent/Paint Hood Exhaust | Stainless Steel |
| Outside Air Intake | Steel |
| Combustion Air | Steel |
| Emergency Generator Ventilation | Steel |

3.6

DUCTWORK HANGERS AND SUPPORTS

- A. All ductwork shall be properly suspended or supported from the building structure. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Strap hanger shall be attached to the bottom of the ductwork, provide a minimum of two screws one at the bottom and one in the side of each strap on metal ductwork. The spacing, size and installation of hangers shall be in accordance with the recommendations of the latest SMACNA edition.
- B. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor with sheet metal screws or rivets. The floor supports may also be secured to ducts by rods, angles or flat bar to the duct joint or reinforcing. Structural steel supports for duct risers shall be provided under this Division.

3.7 **AIR DUCT LEAKAGE:** (FROM SMACNA DUCT STANDARDS LATEST EDITION) TEST ALL DUCTWORK (DESIGNED TO HANDLE OVER 1000 CFM) AS FOLLOWS:

- A. Test apparatus
 1. The test apparatus shall consist of:
 2. A source of high pressure air--a portable rotary blower or a tank type vacuum cleaner.
 3. A flow measuring device consisting of straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly shall be accurately calibrated with its own calibration curve. Pressure and flow readings shall be taken with U-tube manometers.
- B. Test Procedures
 1. Test for audible leaks as follows:
 2. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
 - a. Start the blower with its control damper closed.

- b. Gradually open the inlet damper until the duct pressure reaches 1.5 times the standard designed duct operating pressure.
 - c. Survey all joint for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.
 3. After all audible leaks have been sealed, the remaining leakage should be measured with the orifice section of the test apparatus as follows:
 - a. Start blower and open damper until pressure in duct reaches 50% in excess of designed duct operating pressure.
 - b. Read the pressure differential across the orifice on manometer No. 2. If there is no leakage, the pressure differential will be zero.
 - c. Total allowable leakage shall not exceed one (1) percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
 - d. Even though a system may pass the measured leakage test, a concentration of leakage at one point may result in a noisy leak which, must be corrected.
 4. Test Witness
 - a. Air duct leakage test shall be witnessed by Owner/Engineer.
 - b. The Architect or duly authorized construction inspector shall be notified in writing at least 2 working days prior to each test.
- 3.8 DUCT JOINTS AND SEAMS

- A. Seal all non-welded duct joints with duct sealant as indicated.

END OF SECTION

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**SECTION 23 3300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Round Duct Taps
- D. Duct access doors.
- E. Fire dampers.
- F. Flexible duct connectors.
- G. Smoke dampers.
- H. Volume control dampers.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- B. Section 23 3100 - HVAC Ducts and Casings.

1.4 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- B. NFPA 92 - Standard for Smoke Control Systems; 2015.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2014.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- F. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- G. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.
- C. Project Record Drawings: Record actual locations of access doors and test holes.

1.6 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES

- A. Manufacturers:
 - 1. Krueger-HVAC, Division of Air System Components: www.krueger-hvac.com/#sle.
 - 2. Ruskin Company: www.ruskin.com/#sle.
 - 3. Titus HVAC, a brand of Johnson Controls: www.titus-hvac.com/#sle.
 - 4. Tuttle and Bailey
 - 5. Young Regulator
- B. On duct sizes less than 12 x 12, multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.
- C. Multi-blade device with radius blades attached to pivoting frame and bracket, steel or aluminum construction, with worm drive mechanism with 18 inch long removable key operator.

2.2 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Nailor Industries, Inc: www.nailor.com/#sle.
 - 2. Ruskin Company: www.ruskin.com/#sle.
 - 3. Greenheck: www.greenheck.com
 - 4. American Warming and Vent
 - 5. Titus
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Review locations prior to fabrication
- D. Fabricate rigid and close fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover. Insulation shall be replaceable without field cutting or patching.
- E. Access doors smaller than 12 inches square may be secured with sash locks.
- F. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- G. Access doors with sheet metal screw fasteners are not acceptable.

2.3 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.4 FIRE DAMPERS

- A. Manufacturers:
 - 1. Greenheck: www.greenheck.com
 - 2. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 - 3. Nailor Industries, Inc: www.nailor.com/#sle.
 - 4. Ruskin Company: www.ruskin.com/#sle.
 - 5. NCA Manufacturing, Inc

6. Safe-Air/Dowco

- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.
- D. Multiple Blade Dampers: 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- E. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.5 FLEXIBLE DUCT CONNECTIONS TO AIR MOVING EQUIPMENT

- A. Manufacturers:
 - 1. Metaledge
 - 2. Ventglass
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- C. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz per sq yd, approximately 6 inches wide, crimped into metal edging strip.

2.6 SMOKE DAMPERS

- A. Manufacturers:
 - 1. Greenheck: www.greenheck.com
 - 2. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 - 3. Nailor Industries, Inc: www.nailor.com/#sle.
 - 4. Ruskin Company: www.ruskin.com/#sle.
 - 5. NCA Manufacturing, Inc
 - 6. Safe-Air/Dowco
- B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- C. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by pneumatic actuator.
- D. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.7 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Splitter Dampers:
 - 1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
 - 2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - 3. Operator: Minimum 1/2 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .
- C. Single Blade Dampers:
- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 12x72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware. On outside air, return air, and all other dampers required to be low leakage type, provide galvanized blades and frames, seven inches wide maximum, with

replaceable vinyl, EPDM, silicone rubber seals on blade edges and stainless steel side seals. Provide blades in a double sheet corrugated type construction for extra strength. Provide hat channel shape frames for strength and blade linkage enclosure to keep linkage out of the air stream. Construction leakage not to exceed 1/2%, based on 2,000 fpm and 4 inch static pressure.

- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
- F. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.8 ROUND DUCT TAPS

- A. Taps to trunk duct for round flexible duct shall be spin-in fitting with locking quadrant butterfly damper, model no. FLD-B03 by Flexmaster or approved equal. Damper must be out of main duct airstream when fully open.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.
- B. Provide balancing dampers as follows:
 - 1. Provide at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts and as required for air balancing. Use splitter dampers only where indicated.
 - 2. All regulators mounted on externally insulated ductwork shall have 16 gauge elevated platforms at least 1/8 inch higher than the thickness of the insulation. Damper shaft shall have Ventlock No. 607 bearing mounted on ductwork within elevated platform. If duct is inaccessible the operating handle shall be extended and the regulator installed on the face of the wall or ceiling. Where regulators are exposed in finished parts of the building, they shall be flush type, Ventlock No. 666. All regulators shall be manufactured by Ventlock, or approved equal.
 - 3. All dampers in lined ductwork shall have bushing to prevent damper damage to liner.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- G. Demonstrate re-setting of fire dampers to Owner's representative.
- H. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

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**SECTION 23 3423
HVAC POWER VENTILATORS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof exhausters.
- B. Roof Supply Fans
- C. Utility Fans
- D. Kitchen hood upblast roof exhausters.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 23 0200 - Basic Materials and Methods
- B. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- C. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- D. Section 23 0593 - Testing Adjusting and Balancing
- E. Section 23 3300 - Air Duct Accessories: Backdraft dampers.

1.4 REFERENCE STANDARDS

- A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- B. AMCA 99 - Standards Handbook; 2010.
- C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2007.
- E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2014.

1.5 SUBMITTALS

- A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- B. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.

- C. Coordination drawings, in accordance with Division 23 Section "Basic Materials and Methods", for roof penetration requirements and for reflected ceiling plans drawn accurately to scale and coordinating penetrations and units mounted above ceiling. Show the following:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Ceiling suspension members.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.
 - D. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field- installed wiring.
 - E. Product certificates, signed by manufacturer, certifying that their products comply with specified requirements.
 - F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fan Belts: One set for each individual fan.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Fans shall be stored and handled in accordance with the unit manufacturer's instructions.
 - B. Lift and support units with the manufacturer's designated lifting or supporting points.
 - C. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.
 - D. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
- 1.7 ENVIRONMENTAL REQUIREMENTS
- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- 1.8 FIELD CONDITIONS
- A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.
- PART 2 PRODUCTS
- 2.1 POWER VENTILATORS - GENERAL
- A. Manufacturers:
 - 1. PennBarry
 - 2. Loren Cook Company
 - 3. Greenheck Fan Corporation
 - 4. ACME
 - B. A. Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.
 - C. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
 - D. C. Provide factory baked enamel finish coat after assembly. Color shall be verified during the submittal process.
 - E. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

- F. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
- G. Fabrication: Comply with AMCA 99.
- H. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- B. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure.
 - 1. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections.
 - 2. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Unit shall bear an engraved aluminum nameplate and shall be shipped in transit tested packaging.
- C. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA standard 204-96, balance quality and vibration levels for fans.
- D. Motor shall be heavy duty type with permanently lubricated sealed ball bearings.
- E. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- F. Accessories:
 - 1. Roof Curb: 12 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant and mounting flange for flat roof decks, hinged curb adapter to permit access to dampers and duct connection, 2 inch thick, rigid, fiberglass insulation adhered to inside walls, and 2 inch wood nailer. Size as required to suit roof opening and fan base.
 - 2. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor .
 - 3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base damper tray, factory set to close when fan stops.
 - 4. Dampers: Motor-operated, parallel-blade, volume control dampers mounted in curb base.
- G. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.3 ROOF SUPPLY FANS

- A. Roof-mounted, filtered air supply units are of the belt-driven, double width, double inlet (DWDI), forward curved centrifugal blower type. The unit's blower assembly shall be mounted on vibration isolators. Motor drives shall be machine cast iron and variable pitch and shall be factory set to the specified RPM. Belts shall be non-static and oil resistant. Both motor and

blower bearings shall be permanently lubricated with sealed ball bearings. The blower housing shall be fabricated of heavy gauge painted steel.

- B. Fan shall be listed by Underwriters Laboratories (UL 705) and shall bear the AMCA certified rating seal for sound and air performance.
- C. Units housing shall be minimum 18 gauge extruded aluminum with a removable aluminum cover. The insulated cover shall be held in place with bolts for easy access to fan components.
- D. Filters shall be permanent, one inch, washable, aluminum type and shall be easily removed for cleaning. Units carry the AMCA Certified Ratings Seal for air performance with filters in place.
- E. Accessories: The following items are required.
 - 1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.
 - 2. Bird Screens: Removable ½ inch mesh, 16 gauge, aluminum or brass wire.
 - 3. Dampers: Motor-operated, parallel-blade, volume control dampers mounted in curb base.
 - 4. Roof Curb: Prefabricated, 12 inch high, heavy gauge, galvanized steel; mitered and welded corners; 2 inch thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2 inch wood nailer. Size as required to suit roof opening and fan base.

2.4 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

- A. Belt Drive Fan:
 - 1. Fan Wheel:
 - a. Type: Non-overloading, backward inclined centrifugal.
 - b. Material: Aluminum.
 - 2. Statically and dynamically balanced.
 - 3. Motors:
 - a. Open drip-proof (ODP).
 - b. Heavy duty ball bearing type.
 - c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
 - d. Fully accessible for maintenance.
 - 4. Housing:
 - a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
 - b. Rigid internal support structure.
 - c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
 - d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
 - e. Provide breather tube for fresh air motor cooling and wiring.
- B. Shafts and Bearings:
 - 1. Fan Shaft:
 - a. Ground and polished steel with anti-corrosive coating.
 - b. First critical speed at least 25 percent over maximum cataloged operating speed.
 - 2. Bearings:
 - a. Permanently sealed or pillow block type.
 - b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - c. 100 percent factory tested.
- C. Drive Assembly:
 - 1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.

2. Belts: Static free and oil resistant.
 3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 4. Motor pulley adjustable for final system balancing.
 5. Readily accessible for maintenance.
- D. Disconnect Switches:
1. Factory mounted and wired.
 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 3. Finish for Painted Steel Enclosures: Provide manufacturer's standard unless otherwise indicated.
 4. Positive electrical shutoff.
 5. Wired from fan motor to junction box installed within motor compartment.
- E. Roof Curb: 12 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.
- F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.
- G. Options/Accessories:
1. Automatic Belt Tensioner: Automatic device that adjusts for correct belt tension for single drives.
 2. Clean Out Port: Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
 3. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
 4. Drain Connection:
 - a. Aluminum construction.
 - b. Allows single-point drainage of grease, water, or other residues.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- D. Hung Cabinet Fans:
 1. Install fans with resilient mountings and flexible electrical leads. Refer to Section 22 0548.
 2. Install flexible connections specified in Section 23 3300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- E. Provide sheaves required for final air balance.
- F. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION

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**SECTION 23 3700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers:
 - 1. Perforated ceiling diffusers.
- B. Rectangular ceiling diffusers.
- C. Slot ceiling diffusers.
- D. Registers/grilles:
 - 1. Ceiling-mounted, egg crate exhaust and return register/grilles.
 - 2. Ceiling-mounted, exhaust and return register/grilles.
 - 3. Ceiling-mounted, supply register/grilles.
 - 4. Wall-mounted, supply register/grilles.
- E. Door grilles.
- F. Louvers:
- G. Other air devices indicated on drawings and schedules
- H. Goosenecks.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 23 0200 - Basic Methods and Materials
- B. Section 23 0593 - Testing, Adjusting and Balancing
- C. Section 23 3100 - HVAC Duct and Casings
- D. Section 23 3300 - Air Duct Accessories
- E. Section 08 91 00 - : Louvers.
- F. Section 09 9123 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.4 REFERENCE STANDARDS

- A. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; 2006 (R2011).
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.5 SUBMITTALS

- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, accessories and noise level. 3. Performance data for each type of air distribution devices furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.

- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air distribution devices, indicating materials and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.
- D. Project Record Documents: Record actual locations of air outlets and inlets.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air distribution devices wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air distribution devices in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

1.7 WARRANTY

- A. Warrant the installation of the Work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from defective or nonconforming workmanship.

1.8 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. ARI Compliance: Test and rate air distribution devices in accordance with ARI 650 "Standard for Air Outlets and Inlets".
 - 2. ASHRAE Compliance: Test and rate air distribution devices in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
 - 3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
 - 4. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
 - 5. NFPA Compliance: Install air distribution devices in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Krueger-HVAC: www.krueger-hvac.com/#sle.
- B. Price Industries: www.price-hvac.com/#sle.
- C. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com/#sle.
- D. Nailor Industries
- E. Tuttle & Bailey
- F. Pottoroff

2.2 GENERAL DESCRIPTION

- A. Unless otherwise indicated, provide manufacturer's standard air devices when shown of size, shape, capacity, type and accessories indicated on drawings and schedules, constructed of materials and components as indicated and as required for complete installation and proper air distribution.
- B. Provide air devices that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

- C. Unless noted otherwise on drawings, the finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM D117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250 hour ASTM-870 Water Immersion Test. The paint must also pass the ASTM D-2794 Reverse Impact Cracking Test with a 50 inch pound force applied.
- D. Provide air device with border styles that are compatible with adjacent ceiling or wall system, and that are specially manufactured to fit into the wall construction or ceiling module with accurate fit and adequate support. Refer to architectural construction drawings and specifications for types of wall construction and ceiling systems.
- E. Air devices designated for fire rated systems shall be pre-assembled with UL classified radiation damper and thermal blanket. Fire rated air devices shall be shipped completely assembled; one assembly per carton, Each assembly shall be enclosed in plastic shrink wrap with installation instructions.

2.3 LOUVERS

- A. Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Provide louvers that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with louver schedule.
- C. Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to architectural construction drawings and specifications for types of substrate.
- D. Louvers shall be constructed of aluminum extrusions, ASTM B 221, Alloy 6063-T5. Weld units or use stainless steel fasteners.
- E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.
- F. Acceptable Manufacturers:
 - 1. Ruskin Manufacturing Company
 - 2. Greenheck Company
 - 3. Louvers and Dampers, Inc.
 - 4. Substitutions under provisions of Division One.

2.4 RECTANGULAR CEILING DIFFUSERS

- A. Refer to schedules on drawings.

2.5 PERFORATED FACE CEILING DIFFUSERS

- A. Refer to schedules on drawings.

2.6 CEILING SLOT DIFFUSERS

- A. Refer to schedules on drawings.

2.7 CEILING SUPPLY REGISTERS/GRILLES

- A. Refer to schedules on drawings.

2.8 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Refer to schedules on drawings.

2.9 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

- A. Refer to schedules on drawings.

2.10 WALL SUPPLY REGISTERS/GRILLES

- A. Refer to schedules on drawings.

2.11 DOOR GRILLES

- A. Refer to schedules on drawings.

2.12 LOUVERS

- A. Refer to Sectio 08 91 00.

2.13 GOOSENECKS

- A. Fabricate in accordance with SMACNA (DCS) of minimum 18 gage, 0.0598 inch galvanized steel.
- B. Mount on minimum 12 inch high curb base where size exceeds 9 by 9 inch.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9123.
- F. See floor plans for type, neck size and CFM of air for all air distribution devices.
- G. Install all air distribution devices as detailed on plans and in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common electrical installation requirements.

1.3 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.4 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

- A. Product Data: For sleeve seals.

1.6 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

- E. Right of Way: Give to piping systems installed at a required slope.
- F. Wiring to all non dedicated receptacles and switches are required to utilize parallel circuiting by the use of "pig tails" to each device so that if an outlet is removed or fails, electrical continuity of the circuit will not be compromised.
- G. All electrical wiring must be properly spliced by twisting the wires together and use of approved and listed compression wire nuts for the application..
- H. Do not use end to end butt-splicing connections for any wiring.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

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SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Single conductor building wire.
- B. Underground feeder and branch-circuit cable.
- C. Service entrance cable.
- D. Armored cable.
- E. Metal-clad cable.
- F. Manufactured wiring systems.
- G. Wiring connectors.
- H. Electrical tape.
- I. Heat shrink tubing.
- J. Oxide inhibiting compound.
- K. Wire pulling lubricant.
- L. Cable ties.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 31 23 00 - Excavation and Backfill

1.4 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.

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- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
- I. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); 2007.
- J. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.
- K. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. UL 4 - Armored Cable; Current Edition, Including All Revisions.
- N. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- O. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- P. UL 183 - Manufactured Wiring Systems; Current Edition, Including All Revisions.
- Q. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- R. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- S. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- T. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables; Current Edition, Including All Revisions.
- U. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- V. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Division 1 for Submittal Procedures
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- H. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Purple.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:

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1. Copper Building Wire:
 - a. Alcan Products Corporation; Alcan Cable Division.
 - b. American Insulated Wire Corp.; a Leviton Company.
 - c. General Cable Corporation.
 - d. Senator Wire & Cable Company.
 - e. Southwire Company.
 - B. Description: Single conductor insulated wire.
 - C. Conductor Stranding:
 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
 - D. Insulation Voltage Rating: 600 V.
 - E. Insulation:
 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
- 2.4 UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE
- A. Description: NFPA 70, Type UF multiple-conductor cable listed and labeled as complying with UL 493, Type UF-B.
 - B. Provide equipment grounding conductor unless otherwise indicated.
 - C. Conductor Stranding:
 1. Size 10 AWG and Smaller: Solid.
 2. Size 8 AWG and Larger: Stranded.
 - D. Insulation Voltage Rating: 600 V.
- 2.5 SERVICE ENTRANCE CABLE
- A. Conductor Stranding: Stranded.
 - B. Insulation Voltage Rating: 600 V.
- 2.6 ARMORED CABLE
- A. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.
 - B. Conductor Stranding:
 1. Size 10 AWG and Smaller: Solid.
 2. Size 8 AWG and Larger: Stranded.
 - C. Insulation Voltage Rating: 600 V.
 - D. Insulation: Type THHN.
 - E. Grounding: Combination of interlocking armor and integral bonding wire.
 - F. Armor: Steel, interlocked tape.
- 2.7 METAL-CLAD CABLE
- A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
 - B. Conductor Stranding:
 1. Size 10 AWG and Smaller: Solid.
 2. Size 8 AWG and Larger: Stranded.
 - C. Insulation Voltage Rating: 600 V.
 - D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
 - E. Grounding: Full-size integral equipment grounding conductor.

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F. Armor: Steel, interlocked tape.

2.8 MANUFACTURED WIRING SYSTEMS

- A. Description: Manufactured wiring assemblies complying with NFPA 70 Article 604, and listed and labeled as complying with UL 183.
- B. Provide components necessary to transition between manufactured wiring system and other wiring methods.
- C. Branch Circuit Cables:
 - 1. Conductor Stranding (Size 10 AWG and Smaller): Solid.
 - 2. Insulation Voltage Rating: 600 V.
 - 3. Insulation: Type THHN.
 - 4. Grounding: Full-size integral equipment grounding conductor.
 - 5. Armor: Steel, interlocked tape.
- D. Connectors: Keyed and color-coded to prevent interconnection of different voltages.
- E. Fixture Leads: Type TFN insulation.

2.9 WIRING CONNECTORS

- A. Manufacturers
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
- B. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- C. Connectors for Grounding and Bonding: Comply with Section 26 0526.
- D. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- E. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 - 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
 - 6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
 - 7. Conductors for Control Circuits: Use crimped terminals for all connections.

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- F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- G. Mechanical Connectors: Provide bolted type or set-screw type.
- H. Compression Connectors: Provide circumferential type or hex type crimp configuration.
- I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.10 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.11 ACCESSORIES

- A. Electrical Tape:
 - 1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 - 2. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 - 3. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 - 4. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 - 5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- E. Cable Ties: Material and tensile strength rating suitable for application.

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PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
 - 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
 - 9. Provide oversized neutral/grounded conductors where indicated and as specified below.
 - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
 - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install underground feeder and branch-circuit cable (Type UF-B) in accordance with NECA 121.
- E. Install armored cable (Type AC) in accordance with NECA 120.
- F. Install metal-clad cable (Type MC) in accordance with NECA 120.
- G. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.

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3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- H. Direct Burial Cable Installation:
1. Provide trenching and backfilling in accordance with Sections 31 2316 and 31 2323.
 2. Protect cables from damage in accordance with NFPA 70.
 3. Provide underground warning tape in accordance with Section 26 0553 along entire cable length.
- I. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- J. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- K. Terminate cables using suitable fittings.
1. Armored Cable (Type AC):
 - a. Use listed fittings and anti-short, insulating bushings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 2. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- L. Install conductors with a minimum of 12 inches of slack at each outlet.
- M. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- N. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- O. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- P. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.

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- b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 - Q. Insulate ends of spare conductors using vinyl insulating electrical tape.
 - R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
 - S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- 3.4 FIELD QUALITY CONTROL
- A. Inspect and test in accordance with NETA ATS, except Section 4.
 - B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - C. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

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SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground plate electrodes.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 26 0500 - Electrical Common Work Results
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 4113 - Lightning Protection for Structures.

1.4 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2014.
- F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Field quality control test reports.
- D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
2. Include recommended testing intervals.

E. Qualification Data: For testing agency and testing agency's field supervisor

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with UL 467 for grounding and bonding materials and equipment.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70, but not less than applicable minimum size requirements specified.
- D. Grounding Electrode System:
 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.

4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
5. Ground Ring:
 - a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
 - b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
 - c. Ground ring to be continuous without splices
6. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
- E. Lightning Protection Systems, in Addition to Requirements of Section 26 4113:
 1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
 2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Copper weld
 - b. Cad weld
- D. Ground Bars:
 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: As indicated.
 3. Holes for Connections: As indicated or as required for connections to be made.

- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Stainless steel.
 - 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
- F. Ground Plate Electrodes:
 - 1. Material: Copper.
 - 2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.
- D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.
- E. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- F. Identify grounding and bonding system components in accordance with Section 26 0553.

3.3 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

1.4 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 SUBMITTALS

- A. Sewe Division 1 for Submittal Procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
 3. Manufacturers:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- F. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
 4. Manufacturers:
 - a. PHP Systems/Design: www.phpsd.com/#sle.
 - b. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.

- G. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 4. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 5. Powder-actuated fasteners are not permitted.
 - a. Use only threaded studs; do not use pins.
 6. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
 - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
 7. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - c. Powers Fasteners, Inc: www.powers.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 8. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - c. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
 - H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
 - I. Secure fasteners according to manufacturer's recommended torque settings.
 - J. Remove temporary supports.
- 3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

**SECTION 26 0533.13
CONDUIT FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Intermediate metal conduit (IMC).
- D. PVC-coated galvanized steel rigid metal conduit (RMC).
- E. Flexible metal conduit (FMC).
- F. Liquidtight flexible metal conduit (LFMC).
- G. Electrical metallic tubing (EMT).
- H. Rigid polyvinyl chloride (PVC) conduit.
- I. Electrical nonmetallic tubing (ENT).
- J. Liquidtight flexible nonmetallic conduit (LFNC).
- K. Reinforced thermosetting resin conduit (RTRC).
- L. Conduit fittings.
- M. Accessories.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 07 8400 - Firestopping.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- D. Section 26 0529 - Hangers and Supports for Electrical Systems.
- E. Section 31 23 00 Excavation and Backfill

1.4 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); 2005.
- D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
- G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; 2004.
- H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.

- I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- J. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
- K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
- L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
- M. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series; 2015.
- N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- P. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- Q. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- R. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- S. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- T. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- U. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- V. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- W. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
 6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
- D. Embedded Within Concrete:
1. Within Slab on Grade: Not permitted.
 2. Within Slab Above Ground: Not permitted.
 3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
 5. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.
- E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.
- L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- M. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit, aluminum rigid metal conduit, or reinforced thermosetting resin conduit (RTRC).
- N. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), aluminum rigid metal conduit, or PVC-coated galvanized steel rigid metal

conduit.

O. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

P. Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.2 CONDUIT REQUIREMENTS

A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

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

C. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com/#sle.
2. Republic Conduit: www.republic-conduit.com/#sle.
3. Wheatland Tube, a Division of Zekelman Industries: www.wheatland.com/#sle.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com/#sle.
2. Republic Conduit: www.republic-conduit.com/#sle.
3. Wheatland Tube, a Division of Zekelman Industries: www.wheatland.com/#sle.

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
3. Material: Use aluminum.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5 INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com/#sle.
 - 2. Republic Conduit: www.republic-conduit.com/#sle.
 - 3. Wheatland Tube, a Division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
 - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.6 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 2. Robroy Industries: www.robroy.com/#sle.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. PVC-Coated Fittings:
 - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 - 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 - 3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
 - 4. Material: Use steel or malleable iron.
 - 5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.7 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalthose.com/#sle.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

2.8 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.

2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
 - B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
 - C. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
- 2.9 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 1. Allied Tube & Conduit: www.alliedeg.com/#sle.
 2. Republic Conduit: www.republic-conduit.com/#sle.
 3. Wheatland Tube, a Division of Zekelman Industries: www.wheatland.com/#sle.
 - B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
 - C. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.
- 2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

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

- A. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).
 - B. Supports: Per manufacturer's recommendations.
 - C. Fittings: Same type and manufacturer as conduit to be connected.
- 2.12 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- E. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- F. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- G. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.
- E. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- H. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal all conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.

11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 14. Group parallel conduits in the same area together on a common rack.
- I. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
 9. Use of spring steel conduit clips for support of conduits is not permitted.
 10. Use of wire for support of conduits is not permitted.
 11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
- J. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
 7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- K. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.

2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
 8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- L. Underground Installation:
1. Provide trenching and backfilling in accordance with Sections 31 2316 and 31 2323.
- M. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Secure conduits to prevent floating or movement during pouring of concrete.
- N. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 3000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- O. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.
- P. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
 4. Where conduits are subject to earth movement by settlement or frost.
- Q. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- R. Provide grounding and bonding in accordance with Section 26 0526.
- 3.3 FIELD QUALITY CONTROL
- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
 - B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
 - C. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

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

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 0533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Floor boxes.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0533.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 2726 - Wiring Devices:
 - 1. Wall plates.

1.4 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Division 1 for Submittal Procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 - 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 - 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 - 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 - 3. Use suitable concrete type boxes where flush-mounted in concrete.
 - 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 - 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 - 6. Use shallow boxes where required by the type of wall construction.
 - 7. Do not use "through-wall" boxes designed for access from both sides of wall.
 - 8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 - 9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 - 10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 - 11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 - 12. Wall Plates: Comply with Section 26 2726.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Box Locations:
 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
 2. Unless dimensioned, box locations indicated are approximate.
 3. Locate boxes so that wall plates do not span different building finishes.
 4. Locate boxes so that wall plates do not cross masonry joints.
 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 7. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 8. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.
 9. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- H. Box Supports:
 1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.

2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
- I. Install boxes plumb and level.
 - J. Flush-Mounted Boxes:
 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
 - K. Install boxes as required to preserve insulation integrity.
 - L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
 - M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
 - N. Close unused box openings.
 - O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
 - P. Provide grounding and bonding in accordance with Section 26 0526.
- 3.3 CLEANING
- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.
- 3.4 PROTECTION
- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 26 2726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

1.4 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Division 1 for Submittal Procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Motor Control Centers:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Panelboards:
 - 1) Identify power source and circuit number. Include location when not within sight of equipment.
 - 2) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
 - 3) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - d. Transformers:
 - e. Transfer Switches:
 - 1) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
2. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.

B. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

C. Identification for Raceways:

D. Identification for Devices:

1. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
2. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
3. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

2.3 WIRE AND CABLE MARKERS

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

2.4 UNDERGROUND WARNING TAPE

- A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- B. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
- C. Legend: Type of service, continuously repeated over full length of tape.
- D. Color:

2.5 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 1. Materials:
 2. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

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

3.3 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General purpose transformers.
- B. Shielded transformers.

1.2 BUY AMERICAN COMPLIANCE

1.3 THE CONTRACTOR SHALL COMPLY WITH THE APPLICABLE FAA BUY AMERICAN PREFERENCE REQUIREMENTS SET FORTH IN TITLE 49 OF THE UNITED STATES CODE § 50101, BABA AND OTHER RELATED MADE IN AMERICA LAWS, US STATUTES, GUIDANCE, AND FAA POLICIES WHICH PROVIDE THAT FEDERAL FUNDS MAY NOT BE OBLIGATED UNLESS ALL IRON, STEEL, AND MANUFACTURED GOODS USED IN AIP FUNDED PROJECTS ARE PRODUCED IN THE UNITED STATES, UNLESS THE FEDERAL AVIATION ADMINISTRATION HAS ISSUED A WAIVER FOR THE PRODUCT; THE PRODUCT IS LISTED AS AN EXCEPTED ARTICLE, MATERIAL OR SUPPLY IN FEDERAL ACQUISITION REGULATION SUBPART 25.108; OR IS INCLUDED IN THE FAA NATIONWIDE BUY AMERICAN WAIVERS ISSUED LIST. IF THE CONTRACTOR PROCURES ANY CAPITAL ITEMS WITH FEDERAL FUNDS, IT IS THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN THE BUY AMERICA CERTIFICATION UNDER SUCH REGULATIONS

1.4 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0533.13 - Conduit for Electrical Systems: Flexible conduit connections.

1.5 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.
- B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.
- C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.
- F. NEMA ST 20 - Dry Type Transformers for General Applications; 2021.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.
- J. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.6 SUBMITTALS

- A. See Division 1 for Submittal Procedures.
- B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
- C. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.
- D. Field Quality Control Test Reports.
- E. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- G. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
- H. Qualification Data: For testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Ambient Temperature: Do not exceed 86 degrees F average or 104 degrees F maximum measured during any 24 hour period during and after installation of transformers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com/#sle.
- B. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- C. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- D. ACME Electric Corporation; Power Distribution Products Division.
- E. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
- F. Hammond Co.; Matra Electric, Inc.
- G. Magnetek Power Electronics Group.
- H. Micron Industries Corp.
- I. Myers Power Products, Inc.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for

- the purpose intended.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 - 1. Altitude: Less than 3,300 feet.
 - 2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.
 - 3. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.
 - C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
 - D. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.
 - E. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
 - F. Basic Impulse Level: 10 kV.
 - G. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
 - H. Isolate core and coil from enclosure using vibration-absorbing mounts.
 - I. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 SHIELDED TRANSFORMERS

- A. Description: Self-cooled, two winding, shielded isolation transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. 15 kVA and Larger: Class 220 degrees C insulation system with 115 degrees C average winding temperature rise.
- E. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- F. Winding Taps:
 - 1. Less than 3 kVA: One 5 percent tap above normal full capacity.
 - 2. 3 kVA through 15 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity..
 - 3. 15 kVA through 300 kVA: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity..
- G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- H. Sound Levels: Standard sound levels complying with NEMA ST 20
- I. Winding Shield: Electrostatic, with separate insulated grounding connection.
- J. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor mounting.

- K. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.
- L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding the shield.
 - 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- N. Accessories:
 - 1. Mounting Brackets: Provide manufacturer's standard brackets.
 - 2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
 - 3. Fungus Proofing: Permanent fungicidal treatment for coil and core.
 - 4. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.
- B. A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section 26 0533.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Install transformers plumb and level.
- G. Transformer Support:
 - 1. Provide required support and attachment in accordance with Section 26 0529, where not furnished by transformer manufacturer.
 - 2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
 - 3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
 - 4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- H. Provide grounding and bonding in accordance with Section 26 0526.
- I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
- J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- E. Remove and replace units that do not pass tests or inspections and retest as specified above.
- F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.4 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.5 CLEANING

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

END OF SECTION

**SECTION 26 2416
PANELBOARDS**

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.4 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NEMA PB 1 - Panelboards; 2011.
- E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000 Volts or Less; 2023.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 67 - Panelboards; Current Edition, Including All Revisions.
- J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.5 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.6 SUBMITTALS

- A. See Division 1 for Submittal Procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Qualification Data: For qualified testing agency.
- D. Field Quality Control Test Reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.7 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. 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.
- F. Comply with NEMA PB 1.

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

- b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.
 - 3. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.12 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

- C. Short Circuit Current Rating:
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Provide 200 percent rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression type.
 - 3. Ground Lugs and Bus-Configured Terminators: Compression type.
 - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 4X, stainless steel.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finishes:
 - 1) Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - 2) Back Boxes: Galvanized steel.
 - 3) Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
 - 5. Lockable Doors: All locks keyed alike unless otherwise indicated.
 - 6. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 7. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

8. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- I. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Manufacturers:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. Siemens Energy & Automation, Inc.
 3. Square D; a brand of Schneider Electric
- C. Conductor Terminations:
 1. Main and Neutral Lug Material: Copper suitable for terminating copper conductors only.
 2. Main and Neutral Lug Type: Mechanical.
- D. Bussing:
 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 2. Phase and Neutral Bus Material: Copper.
 3. Ground Bus Material: Copper.
- E. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- F. Enclosures:
 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 3. Provide clear plastic circuit directory holder mounted on inside of door.
- G. Provide column-width panelboards: Narrow gutter extension with cover to overhead junction box equipped with ground and neutral terminal buses where indicated.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. Siemens Energy & Automation, Inc.
 3. Square D; a brand of Schneider Electric
- B. Molded Case Circuit Breakers:
 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Interrupting Capacity:
 - a. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long and short term time pickup, adjustable by setting dial.
 - 2) Instantaneous pickup.
 - 3) Ground fault pickup level, time delay and I²t response.
6. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
7. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
8. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
9. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
10. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - j. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - k. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

- m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 PANELBOARD SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology; a subsidiary of Danahar Corporation.
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 4. Liebert Corporation.
 5. Siemens Energy & Automation, Inc.
 6. Square D; a brand of Schneider Electric.
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
1. Accessories:
 - a. LED indicator lights for power and protection status.
 - b. Audible alarm, with silencing switch, to indicate when protection has failed.
 - c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
1. Accessories:
 - a. Fuses rated at 200-kA interrupting capacity.
 - b. Fabrication using bolted compression lugs for internal wiring.
 - c. Integral disconnect switch.
 - d. Redundant suppression circuits.
 - e. Redundant replaceable modules.
 - f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - g. LED indicator lights for power and protection status.
 - h. Audible alarm, with silencing switch, to indicate when protection has failed.
 - i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - j. Six-digit, transient-event counter set to totalize transient surges.
 2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
 3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - a. Line to Neutral: 70,000 A.
 - b. Line to Ground: 70,000 A.
 - c. Neutral to Ground: 50,000 A.
 4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.
- E. Receive, inspect, handle, and store panelboards according to NECA 407.
- F. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- G. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- G. Install panelboards plumb.
- H. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- I. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- J. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
- K. Provide minimum of four spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and or space designated to be ceiling in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- L. Provide grounding and bonding in accordance with Section 26 0526.
- M. Install all field-installed branch devices, components, and accessories.
- N. Set field-adjustable circuit breaker tripping function settings as indicated.
- O. Provide filler plates to cover unused spaces in panelboards.
- P. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- Q. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- F. Panelboards will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

- D. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

**SECTION 26 2726
WIRING DEVICES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Fan speed controllers.
- D. Receptacles.
- E. Wall plates.
- F. Floor box service fittings.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 26 0533.16 - Boxes for Electrical Systems.

1.4 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- C. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- D. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- G. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
- H. UL 1917 - Solid-State Fan Speed Controls; Current Edition, Including All Revisions.

1.5 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.6 SUBMITTALS

- A. See Division 1 for Submittal Procedures.

- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- D. Samples: One for each type and color of device and wall plate specified.
- E. Field Quality Control Test Reports.
- F. Operation and Maintenance Data:
 - 1. For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.7 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.8 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

1.9 DELIVERY, STORAGE, AND PROTECTION

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
- B. 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2.2 WALL SWITCHES

- A. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
 - 1. Products:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- B. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

1. Products:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
- C. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
 1. Products:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
- D. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.
 1. Products:
 - a. Cooper; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L

2.3 WALL DIMMERS

- A. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472..
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
- E. Provide locator light, illuminated with load off.

2.4 FAN SPEED CONTROLLERS

- A. Description: 120 V AC, solid-state, full-range variable speed, slide control type with separate on/off switch, with integral radio frequency interference filtering, fan noise elimination circuitry, power failure preset memory, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1917.
 1. Current Rating: 1.5 A unless otherwise indicated or required to control the load indicated on the drawings.

2.5 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6111 for 120 V, 6117 for 277 V.
 - b. Hubbell; WS1277.
 - c. Leviton; ODS 10-ID.
 - d. Pass & Seymour; WS3000.
 - e. Watt Stopper (The); WS-200.
 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..
- B. Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; AT120 for 120 V, AT277 for 277 V.
 - b. Leviton; ODS 15-ID.
 3. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..
- C. Long-Range Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP1600WRP.
 - b. Leviton; ODWWV-IRW.
 - c. Pass & Seymour; WA1001.
 - d. Watt Stopper (The); CX-100.
 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft..
- D. Long-Range Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATD1600WRP.
 - b. Leviton; ODW12-MRW.
 - c. Watt Stopper (The); DT-200.
 3. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft..
- E. Wide-Range Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP120HBRP.
 - b. Leviton; ODWHB-IRW.
 - c. Pass & Seymour; HS1001.
 - d. Watt Stopper (The); CX-100-3.
 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

2.6 WALL PLATES

- A. Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard.
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
 - 4. Finished Spaces: Stainless steel wall plates, brushed satin finish, Type 302 stainless steel.
 - 5. Unfinished Spaces: Galvanized steel wall plates, rounded corners and edges, with corrosion resistant screws.
 - 6. Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.7 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
 - 1. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 - 2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
 - 3. Square D/ Schneider Electric.
 - 4. Thomas & Betts Corporation.
- B. Description: Service fittings compatible with floor boxes provided under Section 26 0533.16 with components, adapters, and trims required for complete installation.
 - 1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.
 - 2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
 - 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 4. Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.
 - 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.8 MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Wiremold Company (The).
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: No. 12 AWG.

2.9 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.

3. TVSS Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
 1. Mounting Heights: Unless otherwise indicated, as follows:
 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- I. Install wall switches with OFF position down.
- J. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- K. Verify that dimmers used for fan speed control are listed for that application.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- N. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- O. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 2. Test Instruments: Use instruments that comply with UL 1436.
 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Test straight blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

END OF SECTION

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SECTION 26 2816.13
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.4 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.

1.6 SUBMITTALS

- A. See Division 1 for Submittal Procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device
 - 7. Include characteristic trip curves for each type and rating of circuit breaker upon request.
- C. Field Quality Control Test Reports.

1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Manufacturer's field service report.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.7 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without Owner's written permission.
 4. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I²t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- J. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.2 ENCLOSURES

- A. Enclosed Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install enclosed circuit breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Circuit breakers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- H. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.5 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- C. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION

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**SECTION 26 2816.16
ENCLOSED SWITCHES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.4 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.6 SUBMITTALS

- A. See Division 1 for Submittal Procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- C. Field Quality Control Test Reports.

1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Manufacturer's field service report.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.7 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. 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.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without Owner's written permission.
 4. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

2.2 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. Siemens Energy & Automation, Inc.
 - 3. Square D; a brand of Schneider Electric.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.3 ENCLOSURES

- A. Enclosed Switches: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
- B. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.
- C. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- E. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- F. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- G. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Enclosed switches will be considered defective if they do not pass tests and inspections.
- I. Prepare test and inspection reports, including a certified report that identifies enclosed switches and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

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**SECTION 26 5100
INTERIOR LIGHTING**

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations

1.3 RELATED REQUIREMENTS

- A. Section 26 0529 - Hangers and Supports for Electrical Systems.
- B. Section 26 0533.16 - Boxes for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.4 REFERENCE STANDARDS

- A. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- B. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- C. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).
- D. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems; 2006.
- E. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- H. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. LED Luminaires:
 1. Components: UL 8750 recognized or listed as applicable.
 2. Tested in accordance with IES LM-79 and IES LM-80.
 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.3 BALLASTS AND DRIVERS

- A. Ballasts/Drivers - General Requirements:

1. Driver Manufacturer shall have a ten year history manufacturing drivers in North America Market.
 2. Drivers shall carry a 5 year limited warranty
- B. Dimmable LED Drivers:
1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
 2. Control Compatibility: Fully compatible with the dimming controls to be installed.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of luminaires provided under this section.
- B. Install products in accordance with manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Suspended Ceiling Mounted Luminaires:
 1. Do not use ceiling tiles to bear weight of luminaires.
 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 3. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 4. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- G. Recessed Luminaires:
 1. Install trims tight to mounting surface with no visible light leakage.
 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
- H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- I. Install accessories furnished with each luminaire.
- J. Bond products and metal accessories to branch circuit equipment grounding conductor.
- K. Install lamps in each luminaire.

END OF SECTION

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SECTION 270526
TELECOMMUNICATIONS GROUNDING & BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.
- D. Communication system grounding.
- E. Electrical equipment and raceway grounding and bonding.
- F. Control equipment grounding.

1.2 REFERENCES

- A. Related Specification Sections
 - 1. Section 27 0553 Identification and Labeling of Communication Infrastructure
 - 2. Section 27 1100 Communication Cabinets and Equipment Rooms
 - 3. Section 27 1300 Backbone and Riser Media Infrastructure
 - 4. Section 27 1500 Horizontal Media Infrastructure
 - 5. Section 27 0543 External Communication Pathways
- B. American Society for Testing and Materials (ASTM):
 - 1. B 3 Soft or Annealed Copper Wires
 - 2. B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
 - 3. B 33 Tinned Soft or Annealed Copper Wire for Electrical Purposes
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 142-82 Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - 2. 383-2.5 IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.
 - 3. 1100 IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems.
- D. Underwriters' Laboratories (UL):
 - 1. 83 Thermoplastic Insulated Wire and Cables
 - 2. 96 Lightning Protection Components
 - 3. 96A System Installation
 - 4. 467 Grounding and Bonding Equipment
- E. National Fire Protection Association (NFPA):
 - 1. 780 Lightning Protection Code
 - 2. 70 National Electrical Code (NEC)
 - a. NEC Article No. 250 - Grounding

- F. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance (ANSI/TIA/EIA):
 - 1. J-STD-607-B Commercial Building Grounding and Bonding Requirements.
 - 2. Telcordia – Network Equipment Building Systems (NEBS) GR-1275.
- G. Building Industry Consulting Services International (BICSI):
 - 1. Telecommunications Distribution Methods Manual (Latest Issue)
 - 2. Customer Owned Outside Plant Design Manual (Latest Issue)
 - 3. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
- H. Local, county, state and federal regulations and codes in effect as of date of “notice to proceed” shall be complied with.
- I. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be indicated in the proposal the components which may be of foreign manufacture, if any, and the country of origin.
- J. Reference attached Figure 1 for general grounding infrastructure layout and connectivity.
- K. Conflicts:
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 - 2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

1.3 DESIGN REQUIREMENTS

- A. Design grounding system following ANSI J-STD 607-B – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, BICSI Telecommunications Distribution Methods Manual, NECA/BICSI 607-2011, NEC Article No. 250 - Grounding, IEEE 1100 – Recommended Practices for Powering and Grounding Sensitive Electronic Equipment, and IEEE 142-82 - Recommended Practice for Grounding of Industrial and Commercial Power Systems, by a firm acceptable to Owner's insurance underwriter. All labeling shall follow standards set forth by ANSI/TIA/EIA-606 and Houston Airport System's Information Technology (HAS-IT) requirements.
- B. Design Standards:
 - 1. Completely protect above-surface structures and equipment.
 - 2. Calculate system on the basis of existing soil resistivity.
 - 3. If cathodic protection for underground sewer pipe is installed (see applicable Division 2 Sections), ensure the pipe is not connected to the general grounding system, either directly through grounding cable or indirectly through grounded electrical devices connected to the pipe. Electrically isolate electrical devices from sewer pipe.
- C. Radio Equipment
 - 1. All Radio equipment/systems shall be grounded per Motorola Standard R56.

1.4 SUBMITTALS

- A. Follow Section 01340 for the following:
- B. Product Data:

1. Manufacturers catalog data and applicable special fabrication and installation details.
2. Installation, terminating and splicing procedures.
3. Instructions for handling and storage.
4. Dimensions and weights.
5. Conformance Certificate and Quality Assurance Release: Signed by QAP Manager (Section 01450). Specifically identify products and include purchase order number, supplements, and item number where applicable. Indicate that requirements are met and identify approved deviations.
6. Include spares list to be approved by HAS IT Project Manager for approval.

1.5 QUALITY ASSURANCE

- A. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.
- B. Tests for Insulated Cable: Pass vertical tray flame test following IEEE 383-2.5.
- C. HAS retains the right to inspect all work during the entire duration of the project and any items that do not adhere to the reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

1.6 SHIPPING AND HANDLING

- A. Ship on manufacturer's standard reel sizes of one continuous length. Where cut lengths are specified, mark reel quantity accordingly.
- B. Protect wire wood lagging or suitable barrier across the traverse of reels. Provide heat-shrink self-sealing end caps on cable.
- C. Equipment shall be delivered in original packages with labels intact and identification clearly marked. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other containments. Equipment damaged prior to system acceptance shall be replaced at no cost to the HAS.

1.7 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cable Manufacturers/Suppliers:
 - 1. Houston Wire and Cable Company
 - 2. Okonite Company
 - 3. Anixter
 - 4. Graybar
 - 5. CSC (Communication Supply Company)
 - 6. Cablec Continental Cables Company
 - 7. Pirelli Cable Corporation
 - 8. Triangle Wire and Cable, Inc.

- B. Ground Rod and Connector Manufacturers:
 - 1. Copperweld
 - 2. Thomas & Betts
 - 3. Blackburn

- C. Exothermic Connector Manufacturers:
 - 1. Erico Products (Cadweld)
 - 2. Burndy Corporation (Therm-O-Weld)
 - 3. OZ Gedney

- D. Grounding Connector Manufacturers:
 - 1. Thomas & Betts
 - 2. Burndy Corporation
 - 3. O.Z. Gedney
 - 4. Panduit

- E. Telecommunications Busbars:
 - 1. Erico Products
 - 2. Cooper B-Line
 - 3. CPI Chatsworth
 - 4. Panduit

2.2 MATERIALS

- A. Grounding Conductors: Bare or insulated copper AWG wire following ASTM-B3, ASTM-B8 and ASTM-B33, of following sizes:
 - 1. A minimum of 6 AWG, stranded, insulated (green) copper conductor shall be used for communications since this accommodates different code requirements and allows for future changes.
 - 2. Metallic cable shield shall NOT be used as a Telecommunication Bonding Backbone (TBB).
 - 3. Interior water piping system shall NOT be used as a TBB

- B. Grounding Connectors: It is recommended that connectors should be one of the following:
 - 1. Tin-plated copper.
 - 2. Copper.
 - 3. Copper alloy.

- C. Ground Rods: A minimum of 10 feet long, 3/4-inch diameter, copper-clad steel.

- D. Where single conductor insulated grounding conductors is required, furnish green color (or tape marking) insulation rated for 600 volts.
- E. Telecommunications Main Grounding Busbar (TMGB):
 - 1. The TMGB shall be a predrilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two holed lugs must be attached to busbar)
 - 2. The TMGB shall be sized for the immediate requirements and allow for 100% growth.
 - 3. The minimum busbar dimensions are .25" thick x 4" wide x 20" long.
 - 4. The busbar shall be electrotin plated for reduced contact resistance.
- F. Telecommunications Grounding Busbar (TGB):
 - 1. The TGB shall be a predrilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two holed lugs must be attached to busbar)
 - 2. The TGB shall be sized for the immediate requirements and allow for 100% growth.
 - 3. The minimum busbar dimensions are .25" thick x 2" wide x 12" long.
 - 4. The busbar shall be electrotin plated for reduced contact resistance.
- G. Rack-Mounted Grounding Busbar (RMGB):
 - 1. The RMGB shall be a predrilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two holed lugs must be attached to busbar)
 - 2. The TGB shall be sized for the immediate requirements and allow for 100% growth.
 - 3. The minimum busbar dimensions are 3/16" thick x 19" wide x 3/4" long.
 - 4. The busbar shall be electrotin plated for reduced contact resistance.

PART 3 - EXECUTION

3.3 PREPARATION

- A. Complete site preparation and soil compaction before trenching and driving ground rods for underground use.
- B. Verify exact location of stub-up points for grounding of equipment, fences and building or steel structures.
- C. Verify wiring for lighting systems is single conductor cable in conduit and each conduit contains a green-color insulated equipment-grounding conductor connected to lighting system. If no ground conductor is present, install conductors as required.
- D. Copper and copper alloy connections shall be cleaned prior to connection.
- E. In new construction, the electrical contractor must provide accessible means to a direct electrical service ground, which is one of the best points for grounding communications systems. NEC Section 250.94 and 800.100 requires an intersystem bonding connection accessible at the electrical service equipment, such as:
 - 1. Approved external connection on the power service panel. The NEC allows

- direct connection to a provided minimum 6 AWG copper conductor. See Chart 1
2. Exposed metallic service raceway (using an approved bonding connector).
 3. Grounding electrode conductor.
 4. For connectivity between buildings and rooms, all bonding conductors are to be placed in conduit end to end and conduit shall be properly grounded. 3/0 conductor to be placed in 2 inch conduit and minimum 6 AWG to be placed in a 1 inch conduit run.

| TBB Conductor Size vs. Length | |
|---|-------------|
| TBB/GE Linear Length | TBB/GE Size |
| Feet (m) | (AWG) |
| Less than 13' (4) | 6 |
| 14–20' (4 -6) | 4 |
| 21–26' (6–8) | 3 |
| 27–33' (8–10) | 2 |
| 34–41' (10–13) | 1 |
| 42–52' (13–16) | 1/0 |
| 53–66' (16–20) | 2/0 |
| 37–84' (20–26) | 3/0 |
| 85–105' (26–32) | 4/0 |
| *Reference ANSI-J-STD-607-B for more information. | |

Chart 1

3.4 INSTALLATION

- A. Install work following drawings, manufacturer’s instructions and approved submittal data.
- B. Bonding conductors shall be routed with minimum bends or changes in direction and shall be made directly to the points being bonded, and shall be one continuous run NO splices.
- C. Bonding connections shall be made by using:
 1. Double crimp connectors only for all horizontal runs (cabinets trays etc.). Use listed hardware that has been laboratory tested. For double crimp connectors use 2 hole type connector.
 2. Exothermic welding (per NEC) within the ground electrode system, for parts of a grounding system that are subject to corrosion or that must carry high currents reliably, or for locations that require minimum maintenance. Exothermic-weld to be used on the Telecommunications Bonding Backbone (TBB) conductor for all connections.
- D. Install main ground loop minimum 18” (inches) below ground surface.
- E. Drive grounding rods vertically, so at least 8 feet of rod is in contact with the soil. All connections shall be exothermic-weld. Install additional ground rods as required to pass resistance test.
- F. Make connections only to dry surfaces with paint, rust, oxidation, scales, grease, dirt or other foreign material is removed. Ensure proper conductivity.
- G. Make above-grade grounding connections with Exothermic-weld.
 1. Ground small groups of isolated equipment with No. 3/0 minimum insulated conductor connected to the main loop.

- H. Equipment Grounding:
 - 1. Make grounding connections to electrical equipment, vessels, mechanical equipment, equipment enclosure, relay racks, and ground rods in accordance with NEC.
 - 2. Make grounding connections to tanks and vessels to integral structural supports or to existing grounding lugs or pads, and not to the body of the tank or vessel.

- I. Telecommunications Raceway and Support Systems Grounding:
 - 1. Bond and ground raceway, cable rack or tray and conduit together and permanently ground to the equipment grounding busbar. Connection to conduit may be with grounding bushing.
 - 2. Connect ladder-type cable tray to grounding electrode system. Telecommunications cable tray that is located in the same room, as the TGB shall be connected to the TMGB.
 - 3. Bond and ground raceway at low voltage motor control centers or other low voltage control equipment, except conduit which is effectively grounded to sheet metal enclosure by bonding bushing or hubs need not be otherwise bonded.
 - 4. Where only grounding conductor is installed in a metal conduit, bond both ends of conduit to grounding conductors.
 - 5. Provide flexible "jumpers" around raceway expansion joints and across cable tray joints parted to allow for expansion and hinged cable tray connections. Provide copper bonding straps for steel conduit.

- J. Telecommunications Grounding and Bonding Infrastructure:
 - 1. Install the TMGB in the Telecommunications Entrance Facility (TEF) or Main Distribution Frame (MDF) as close to the panel-board as possible. The TMGB shall also be located so that the bonding conductor is as short and straight as possible. Maintain clearances required by applicable electrical codes.
 - 2. If a panel-board is not installed in the TEF or MDF, locate the TMGB near the backbone cabling and terminations.
 - 3. The TMGB shall be insulated from its support with a recommended separation of 2 inches.
 - 4. Connect the TMGB to the electrical service ground and telecommunications primary protectors.
 - 5. The minimum Telecommunications Bonding Backbone (TBB) conductor size shall be No. 2 AWG. The TBB originates at the TMGB and extends throughout the building using the telecommunications backbone pathways, and connects to the TGB(s) in all telecommunication closets and equipment rooms.
 - 6. Install the TGBs in the telecommunications closets and equipment rooms as close to the panel-board as possible. The TGB shall also be located so that the bonding conductor is as short and straight as possible. Maintain clearances required by applicable electrical codes.
 - 7. The TGB shall be insulated from its support with a recommended separation of 2 inches.
 - 8. Properly bond and ground all communications cabinets, equipment racks, raceway, cable rack or tray, and conduit directly to TMGB or TGB. Daisy chaining of equipment is not permitted
 - 9. Refer to the Telecom Grounding diagram in the design documentation (see figure 1).
 - 10. Preparation: Copper and copper alloy connections shall be cleaned prior to connecting.
 - 11. Bonding conductors shall be routed with minimum bends or changes in direction and shall be made directly to the point being bonded. Change of direction shall be taken over as wide a radius as possible with a minimum radius of one foot.

12. Make connections only to dry surfaces with paint, rust, oxides, scales, grease and dirt removed. Ensure proper conductivity.
13. Grounding conductors, by gauge, shall be continuous, with splices, from a larger gauge feeder to the last frame or component served by the grounding lead (ex. 750 KCM to 500 KCM to 1/0, etc.).
14. C-Taps from Aisle equalizer to a frame can be the same gauge (ex. E.g., 6 AWG to 6 AWG).
15. Cable to Cable taps shall be made with exothermic weld, or listed compression connectors.
16. No aluminum conductors or connectors shall be used in any bonding and grounding system.
17. Ground bars not supplied as part of a standard assembly shall be copper or tinned copper.
18. Refer Telecommunications Grounding drawings for additional information.
19. Both ends of the grounding conductors shall be equipped with a printed destination label recording the far end termination. The label shall be applied within 6 inches of the termination and be visible from the floor.
20. All metallic items that interact electro-magnetically with Network/Telecommunications equipment shall have their framework bonded and grounded to the Telecommunications grounding system with a minimum #6 AWG grounding conductor. Example includes switch frames, power plants frames, battery stands, storage cabinets and other metallic objects, etc. "Daisy Chaining" or frame to frame connecting of these conductors is NOT permitted.
21. TMGB and TGB shall be stenciled and labeled per HAS requirements.

K. Fences and Gates in the equipment rooms:

1. Ground fences, fence posts and gates to nearest TMGB or TGB.

L. Telecommunications Cable Armored and/or Shielded:

1. Terminate and ground shield of shielded control cable at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables. Maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes or other splice points.
2. Connect ground wire in power cable assemblies at each terminal point to a ground bus, if available, or to the equipment enclosure. Do not extend these ground wires through "doughnut" CTs used for ground fault relaying, but do extend ground leads from stress cones. Ground power cable armor and shield at each terminal point.
3. Bond and ground exposed cable shields and metallic sheaths according to the manufacturer's guidelines. They shall also be grounded as close as possible to the point of entrance.
4. Intra-building telecommunications cabling that is armored or has a metallic shield must be bonded to the building grounding system at each end.

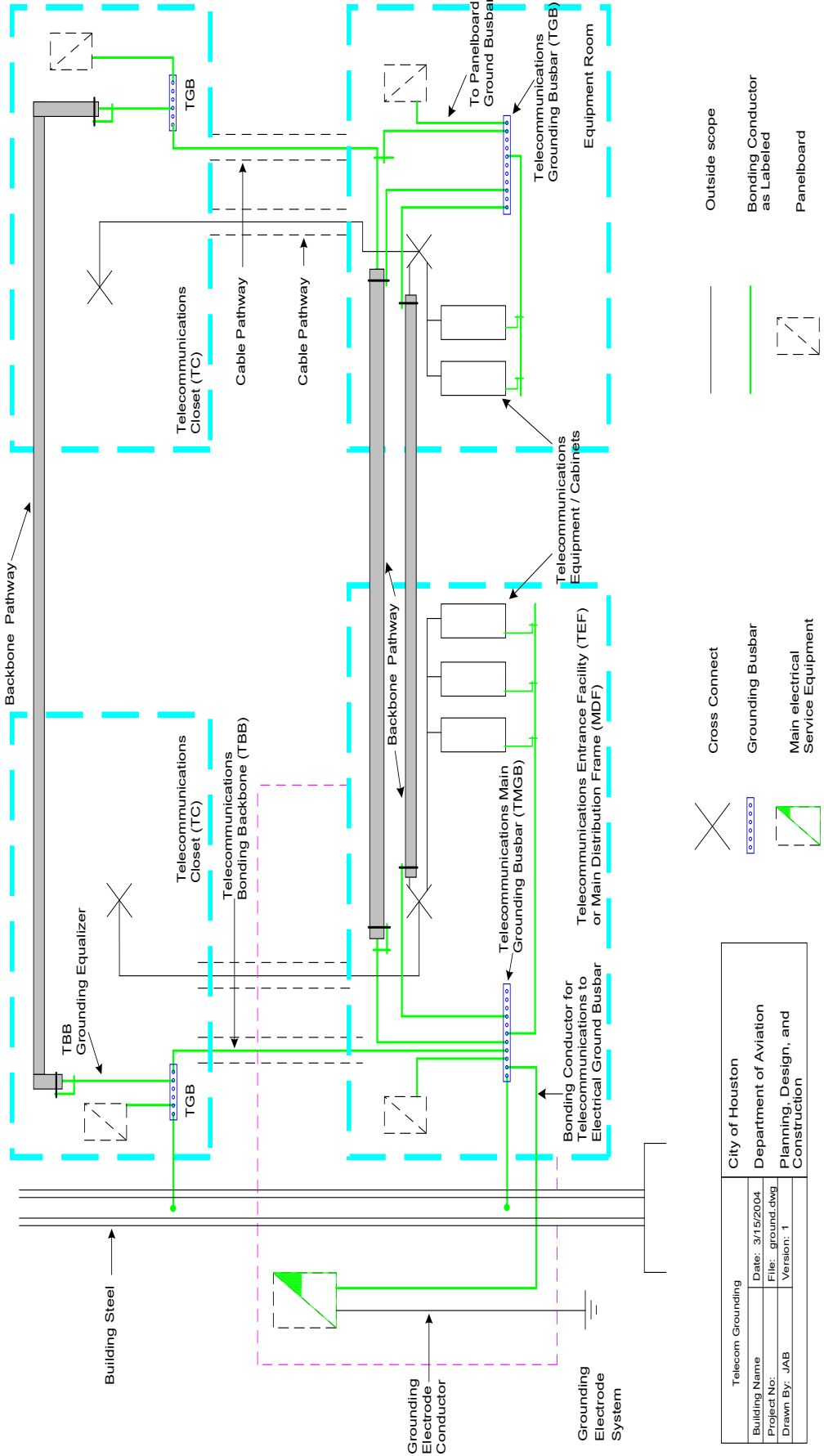
3.5 TESTING

- A. Follow Section 01450.
- B. Test grounding system before grid trenches are back-filled. Test for ground resistance after installation of underground grid and grounding connections.
- C. Install ground access test wells at locations as required for testing, using a pipe surrounding the rod and connections with a cover placed on top at grade level.
- D. Test system resistance at each test well using "Fall of Potential" method Per IEEE Standard No. 81-1983) with a maximum resistance of 5 ohms.
- E. Upon completion of the electrical system, including all grounding, the Electrical Contractor shall test the system for stray currents, ground shorts, etc. Approved instruments, apparatus, service, and

qualified personnel shall be utilized. If stray currents, shorts, etc., are detected, eliminate or correct as required. The test procedure shall be as follows:

1. Open all main disconnects for the system being tested.
2. Disconnect the system neutral from the service entrance or step-down transformer neutral connection.
3. Connect a DC ohmmeter across the system neutral and equipment ground.
4. An ohmmeter reading in excess of 100 ohms shall indicate that the system neutral and equipment ground are properly isolated.
5. An ohmmeter reading less than 100 ohms shall indicate that the system contains ground shorts (stray currents) at some point along the system neutral.
6. Grounded neutrals may be identified by disconnecting individual neutral conductors from the system, one at a time, while monitoring the ohmmeter.
7. The systems shall be re-tested after correction of all ground shorts is complete.

END OF SECTION 27 0526



| Telecom Grounding | |
|-------------------|------------------|
| Building Name | Date: 3/15/2004 |
| Project No. | File: ground.dwg |
| Drawn By: JAB | Version: 1 |

City of Houston
 Department of Aviation
 Planning, Design, and
 Construction

- ✕ Cross Connect
- ⬜ Grounding Busbar
- ⬜ Main electrical Service Equipment
- Outside scope
- Bonding Conductor as Labeled
- Panelboard

Figure 1

SECTION 270528
INTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

- A. Renovation of the Mickey Leland International Terminal Building.

1.2 SECTIONS INCLUDES

- A. This section includes specifications for the installation of interior communications pathways.
- B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.
- C. Interior Communication Pathways are defined to include, but are not limited to innerduct, flexible multi-cell innerduct, conduit, pull boxes, cable/j-hooks, cable trays, supports, accessories, associated hardware and fire stopping materials.

1.3 REFERENCES

- A. Related Sections: Use these Specifications for all related work not specifically covered in this specification.
 - 1. Section 27 05 26: Telecommunication Grounding and Bonding
 - 2. Section 27 05 43: Exterior Communication Pathways
 - 3. Section 27 05 53: Identification and Labeling of Communication Infrastructure
 - 4. Section 27 11 00: Communication Cabinets and Equipment Rooms
 - 5. Section 27 13 00: Backbone and Riser Media Infrastructure
 - 6. Section 27 15 00: Horizontal Media Infrastructure
 - 7. Section 27 21 00: Data Communication Network Equipment
 - 8. Section 27 22 00: PC, Laptop, Servers and Equipment
 - 9. Section 27 51 13: Audio Communication System
 - 10. Section 28 13 00: Access Control System
 - 11. Section 28 23 00: Video Surveillance Control and Management System
- B. American National Standards Institute / Telecommunications Industry Association / Electronic Industries Alliance (ANSI/TIA/EIA): Most current standard revision
 - 1. 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 2. 568-D, Commercial Building Telecommunications Cabling Standard
- C. American National Standards Institute (ANSI):
 - 1. C80.1 Rigid Steel Conduit - Zinc Coated
 - 2. C80.4 Fittings for Rigid Metal Conduit
- D. Federal Specifications (FS):
 - 1. W-C-58C Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron
 - 2. W-C-1094 Conduit and Conduit Fittings Rigid
 - 3. WW-C-581D Coatings on Steel Conduit
- E. Building Industry Consulting Services International (BICSI):
 - 1. Telecommunications Distribution Methods Manual (latest issue)

2. Customer Owned Outside Plant Design Manual (latest issue)
- F. National Electrical Manufacturers Association (NEMA).
1. VE 1-1998 - Metallic Cable Tray Systems
 2. VE 2-2000 - Cable Tray Installation Guidelines
 3. RN1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
 4. TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
 5. TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing
- G. Underwriters laboratories (UL) Cable Certification and Follow Up program
1. UL 6: Rigid Metal Electrical Conduit.
 2. UL 514B: Fittings for Conduit and Outlet Boxes.
 3. UL 651: Schedule 40 and 80 Rigid PVC Conduit.
 4. UL 651A: Type EB and A Rigid PVC Conduit and High-Density Polyethylene (HDPE) Conduit.
 5. UL 886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
- H. American Society for Testing Materials (ASTM).
1. ASTM B633 – specification for Electro-Deposit Coating of Zinc on iron and Steel.
 2. ASTM A653 – Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process.
 3. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
 4. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability (Formerly ASTM A570 &A607)
 5. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A611)
- I. National Electrical Code (NEC latest issue).
- J. Institute of Electrical and Electronic Engineers (IEEE).
- K. Systemax generic specifications: Fiber Optic outside Plant Cable, Latest issue.
- L. International Standards Organization/International
- M. Electromechanical Commission (ISO/IEC) DIS 11801
- N. Conflicts:
1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.
- 1.4 SUBMITTALS
- A. Submit Shop Drawings to include but not limited to plan and section drawings detailing proposed communication pathway routing prior to installation. Communication pathway installation plan to include but not limited to:
1. Room penetration plan.
 2. Communication pathway extension plan.
 3. Riser conduit anchoring plan.

4. Conduit chase plan.
 5. Communication pathway labeling plan.
 6. Junction box, gutter, and pull-box labeling plan.
- B. Shop Drawings shall be submitted and approved before implementation is started. Shop Drawings shall be submitted in accordance with Specification 01340.
- C. Submit prototype test reports for all vault covers verifying conformance to the specification requirements in this document and HAS.
- D. Submit catalog data sheets of conduit, innerduct, raceway, cable tray, cable hook, and associated hardware. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.
- E. Test Reports: Submit certified test reports indicating compliance with material reference standard indicated for material performance characteristics and physical properties of fire stopping materials
- F. Certificates: Submit product certificates, signed by manufacturer certifying materials comply with specified performance characteristics and physical properties of fire stopping materials.
- G. Copy of Building Industry Consulting Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for Contractor's on-site RCDD supervisor. RCDD shall supervise all parts of communications installation at all times.

1.5 QUALITY ASSURANCE

- A. Verify conduit, raceway, cable tray runs, etc. Shall not interfere with existing or new systems within each facility.
- B. Fire stopping: Manufacturer trained and approved installer to perform fire-stopping work who has specialized in the installation of work similar to that required for this project.
- C. Communication Pathway Minimum Clearances:
1. Motors or transformers: 4 feet
 2. Power cables and conduits: 1 foot parallel, 3 inches crossover
 3. Fluorescent lights: 5 inches
 4. Above ceiling tiles: 3 inches
 5. Access above cable tray: 12 inches
 6. Hot Flues, Steam pipes, Hot water pipes and other hot surfaces: at least 6"
- D. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.
- E. 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.
- F. All installed materials and accessories shall be new from the manufacture. No used components shall be accepted by HAS.
- G. All Documentation submittals shall be reviewed by the supervising RCDD and stamped prior to submittal.

- H. Contractor Qualifications:
 - 1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
 - 2. A BICSI RCDD shall supervise ALL work on-site. Must demonstrate knowledge and compliance with all BICSI, ANSI/TIA/EIA, UL, and NEC standards, and codes.
- I. HAS retains the right to have access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at NO cost to HAS.
- J. All communication media will be installed in conduit or cable tray unless alternate method has been approved by HAS/IT.
 - 1. Exception: MATV/CATV horizontal media must be installed in conduit from faceplate to MDF/IDF

1.6 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Where conduit, pull boxes, cable tray and other raceway sizes are not specifically shown on contract drawings. All communication pathways shall be sized in accordance with the requirements of BICSI and the NEC. No conduit shall be less than 1". [Except for those locations specified in the contract documents under section 281300 Access Control with HAS approval.]
- B. All raceways exposed to the elements or possible physical damage or installed below 8 feet shall be Rigid Metal Conduit.
- C. Raceway exposed to elements, not exposed to physical damage and above 8 feet shall be Intermediate Metal Conduit.
- D. Raceways installed in stud walls or above suspended ceilings shall be Electrical Metallic Tubing.
- E. All backbone and riser conduits installed shall be populated with MaxCell flexible innerduct. Cable fill ratio not to exceed 40%.

2.2 CONDUIT AND ACCESSORIES

- A. MANUFACTURES:
 - 1. Allied
 - 2. Triangle
 - 3. Wheatland

- B. Rigid Steel Conduit shall pass all bending, ductility, and thickness of zinc coating in ANSI C80.1 and UL 6. Conduit shall be galvanized have threaded end with 1” minimum size and 4” maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.
- C. Intermediate Metal Conduit (IMC) shall be manufactured in accordance with UL 1242. Conduit shall be low carbon, hot-dipped galvanized inside and out, with threaded ends, 1” minimum size, and 4-inch maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.
- D. Electrical Metallic Tubing (EMT) shall be manufactured in accordance with UL 797 and ANSI C80.3. EMT shall be high-strength, zinc-coated, 1-inch minimum size. EMT may be used for sizes greater than 2" where physically protected. EMT shall not be utilized for service entrance conductors. Fittings shall be of same finish and material as tubing. Fittings shall be compression type with insulated throat and screw on bushings.
- E. Expansion Joint Fittings: OZ type AX or Appleton type XJB, watertight, permitting two-way movement up to 4 inches, equipped with bonding jumpers around or through each fitting.
- F. Thruwall Sealing Fittings: Type WSK by O-Z Gedney Company.
- G. Fire-Seal Fittings: Type CFSI by O-Z Gedney Company.
- H. Sealing Material for Sealing Fittings: Chico X Fiberdam, and Chico A sealing compound, or Chico A-P interpak by Crouse-Hinds or Apelco sealing cement and fiber filler by Appleton.
- I. Insulated Bushings: Type B or SBT, as applicable, by O-Z Gedney or series B1900, series BU500 or series TC700, as applicable, by Steel City.
- J. Provide a measured pull tape in each empty conduit, empty innerduct for backbone and riser pathways.
- K. Provide a pull string for all horizontal conduits with a minimum pulling tension of 200 pounds.
- L. Thread lubricant/sealant shall be Crouse-Hinds type STL or T & B Kopr-Shield except, when required on joints for heat producing elements such as lighting fixtures; it shall be Crouse-Hinds type HTL.
- M. PVC Conduit shall not be used in intercommunication pathways. Except when encased in concrete.

2.3 FLEXIBLE MULTI-CELL INNERDUCT

- A. Manufacturers:
 - 1. MaxCell
 - 2. Or HAS approved equivalent
- B. Flexible Innerduct
 - 1. Flexible innerduct is the HAS standard for multi-path applications within conduit.
 - 2. All riser/backbone fiber shall be installed in flexible innerduct.
 - 3. Flexible Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024A.
 - 4. All flexible innerduct shall be installed per manufacture requirements.
 - 5. Only manufacturer’s fittings, transition adapters, terminators, accessories, and installation kits shall be used.
 - 6. All flexible innerduct will be populated with a measured pull tape.
 - 7. All interior flexible innerduct shall be plenum rated.

8. Flexible innerduct shall only be used when installed in conduit and shall consist of a different color for the maxcell.

MaxCell 4" 3 Cell

| Min Conduit ID | Suggested Product | Max # of Packs | Max # of Cables | Maximum Cable Diameter per Cell | Rec. Pull Length* | Max Pull Length* |
|----------------|-------------------|----------------|-----------------|---------------------------------|-------------------|------------------|
| 3" | MaxCell 4" 3 Cell | 1 | 3 | 1.34" | 1500' | 2000' |
| 4" | MaxCell 4" 3 Cell | 2 | 6 | 1.34" | 1500' | 2500" |
| 5" | MaxCell 4" 3 Cell | 3 | 9 | 1.34" | 1500' | 2500' |
| 6" | MaxCell 4" 3 Cell | 4 | 12 | 1.34" | 1500' | 2500' |

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

MaxCell 3" 3 Cell

| Min Conduit ID | Suggested Product | Max # of Packs | Max # of Cables | Maximum Cable Diameter per Cell | Rec. Pull Length* | Max Pull Length* |
|----------------|-------------------|----------------|-----------------|---------------------------------|-------------------|------------------|
| 3" | MaxCell 3" 3 Cell | 2 | 6 | 1.03" | 1200' | 2000' |
| 4" | MaxCell 3" 3 Cell | 3 | 9 | 1.03" | 1500' | 2500" |
| 5" | MaxCell 3" 3 Cell | 4 | 12 | 1.03" | 1500' | 2500' |
| 6" | MaxCell 3" 3 Cell | 5 | 15 | 1.03" | 1500' | 2500' |

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

MaxCell 2" 3 Cell

| Min Conduit ID | Suggested Product | Max # of Packs | Max # of Cables | Maximum Cable Diameter per Cell | Rec. Pull Length* | Max Pull Length* |
|----------------|-------------------|----------------|-----------------|---------------------------------|-------------------|------------------|
| 2" | MaxCell 2" 3 Cell | 1 | 3 | .70" | 800' | 1500' |

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

2.4 INNERDUCT

A. Manufacturers:

1. Carlon
2. Pyramid
3. Or HAS approved equivalent

B. Innerduct

1. All fiber placed in cable tray shall be installed in corrugated innerduct.
2. One-inch corrugated non-metallic innerduct.
3. Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024.

4. Only manufacturer's fittings, transition adapters, terminators, and fixed bends shall be used.
5. All empty innerduct will be populated with a measured pull tape.
6. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color from end to end (ex. Orange, Blue, Black, and White). Do not couple innerduct of different colors without HAS approval.
7. All interior innerduct shall be plenum rated, unless installed in conduit.

2.5 CABLE TRAYS

A. Manufacturers:

1. B-Line
2. Cope
3. Panduit

B. Cable Tray

1. Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
2. Materials and Finish: Material and finish specifications for each tray type are as follows:
 - a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
 - b. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties in accordance with ASTM A653 SS.
 - c. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray.
 - d. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.
 - e. Rigid PVC (Channel), ABS (Fittings) with the Flammability rating 94V-0, UL listed to 2024A Optical Fiber Cable Routing Assemblies Compliant with the applicable tests in Telcordia GR-63-CORE Network Equipment Building Systems Level 3

2.6 TYPE OF TRAY SYSTEMS

- ### A.
- Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 or 12 inches on center. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiuses edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200-pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.

- B. Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4-inch rectangular holes punched along the width of the bottom.
 - C. All tray sizes and types shall have a minimum of 4-inch usable load depth.
 - D. All straight sections shall be supplied in standard 10-foot length, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
 - E. Tray widths shall be 6, 12, 18, 24, or 36 inches.
 - F. All fittings must have a minimum radius of 12, 24, 36, or 48 inches.
 - G. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
 - 1. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1.
 - 2. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.
 - H. Cable Tray Support shall be placed so that the support spans do not exceed maximum span indicated on drawings or by the manufacturer. Supports shall be Trapeze style support. Cable trays installed adjacent to walls shall be supported on wall-mounted brackets as specified by the manufacturer.
 - I. Trapeze hangers shall be supported by 3/8-inch (minimum) diameter all thread rods.
 - J. Accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, waterfall plates, barriers, etc.
 - K. All cable tray components and accessories will be from the same manufacturer. Parts from different manufacturer will not be intermixed.
- 2.7 CABLE HOOK SYSTEMS (J-Hooks)
- A. Cable hooks must be pre-approved by HAS/IT prior to installation.
 - B. Cable hooks shall have a flat bottom and provide a minimum of 1-5/8-inch cable bearing surface.
 - C. Cable hooks shall have 90-degree radiused edges to prevent damage while installing cables.
 - D. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.
 - E. Cable hooks shall have a cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.

- F. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.
- G. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.
- H. Cable hooks for corrosive areas shall be stainless steel, AMERICAN IRON STEEL INSTITUTE Type 304.
- I. All Cable Hooks shall be supported with minimum ¼” all thread with the appropriate fasteners.

2.8 FIRESTOPPING MATERIALS

- A. Manufacturers:
 - 1. Johns Manville
 - 2. Hilti
 - 3. 3M
 - 4. Unique
- B. Description:
 - 1. Performance requirements: Provide firestopping systems that are produced and installed to resist spread of fire according to requirement indicated, resist passage of smoke and other gases, and maintain fire resistance rating of assembly.
 - a. F-Rated Systems: in accordance with ASTM E 814
 - b. T-Rated Systems: in accordance with ASTM E 814
 - 2. Fire stopping flame spread performance requirements: Provide products with flame-spread ratings of less than 25 and smoke development ratings of less than 50 as determined in accordance with ASTM E 84.
 - 3. Fire Stopping UL performance requirements: Provide products with UL ratings specified for assembly indicated as determined in accordance with UL listings.

2.9 JUNCTION BOXES/PULL BOXES

- A. All pull boxes shall be constructed with a minimum of 14 gauge-galvanized steel with an ANSI 61 grey polyester powder finish inside and out over phosphatized surfaces or galvanizes steel unless otherwise specified.
- B. All pull boxes shall have flat, removable covers fastened with plated steel screws with unique keyhole screw slots in the cover to permit removal of the cover without extracting screws unless otherwise specified.
 - 1. All removable box covers shall be connected to box with a safety strap or chain for all boxes 8” X 8” or larger.
- C. All pull boxes shall provide the appropriate provisioning for grounding.

- D. All pull boxes shall be NEMA Type 1 and sized according to the table below unless otherwise specified.

| Maximum Trade Size of Conduit (inches) | Minimum Box Size (inches) | | | For Each Additional Conduit Increase Width (Inches) |
|--|---------------------------|--------|-------|---|
| | Width | Length | Depth | |
| 1 | 4 | 16 | 3 | 2 |
| 1.25 | 6 | 20 | 3 | 3 |
| 1.5 | 8 | 27 | 4 | 4 |
| 2 | 8 | 36 | 4 | 5 |
| 2.5 | 10 | 42 | 5 | 6 |
| 3 | 12 | 48 | 5 | 6 |
| 3.5 | 12 | 54 | 6 | 6 |
| 4 | 15 | 60 | 8 | 8 |

2.10 WALL BACKBOARD

- A. Reference Specification 271100 Section 2.04

PART 3 - EXECUTION

3.1 GENERAL

- A. Raceways shall be mechanically and electrically connected to all boxes and fittings and shall be properly grounded per NEC.
- B. The routing and location of all conduits, cable tray, cable hooks and other raceways shall be coordinated with other trades prior to and during building construction to avoid delays and conflicts.
- C. Where raceways pass through walls, partitions and floors, seal penetrations to provide a neat installation, which will maintain the integrity of the waterproofing or fireproofing, as applicable, of the structure. Coordinate installation requirements with roofing installer where conduits pass through the roof.
- D. All raceways entering a building from underground shall be sealed to prevent water, moisture, gas, or any other foreign matter from entering the building. Service conduits shall be sealed in accordance with NEC 230-8.
- E. Contractor's on-site RCDD supervisor shall review, approve, and stamp all shop drawings, coordination drawings and records drawings.
- F. Do NOT route communication pathways under HVAC condensing units.
- G. Expansion Fittings:
1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
 2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceways systems

3.2 CONDUIT INSTALLATION

- A. Rigid and IMC shall be installed with threaded fittings and couplings.
- B. All metallic couplings, connectors, and fittings shall be malleable iron or steel and finished with zinc plating or by galvanizing.
- C. All conduits shall be plugged immediately upon installation to prevent the entrance of construction dirt and debris. All conduits shall be swabbed and cleaned before wires are pulled.
- D. Expansion fittings shall be utilized in all cases where conduits pass through building expansion joints. Fittings shall be of an approved weatherproof telescopic type permitting a movement of up to four inches and shall be provided with approved bonding jumpers around or through the fitting.
- E. Connection of Conduit to pull / junction Boxes and Enclosures:
 - 1. Connection to NEMA 1 type boxes and enclosures:
 - a. Rigid: Install insulated bushings and double locknuts.
 - b. IMC: Install insulated bushings and double locknuts.
 - b. EMT: shall be installed with compression box connectors, insulated throats and bushings.
 - 2. Connection to NEMA 3R, 4, 4X, and 12 type boxes: Install insulated bushings and sealing locknuts or hubs.
 - 3. When conduits enter floor mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit. Bond bushings to ground bus using a conductor the same size as required for an equipment grounding conductor sized for the given circuit.
 - 4. Install sealing bushing within all conduits which have entered a building
From outside, whether from above or below grade.
- F. No section of conduit shall be longer than 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with the offset as described herein is considered a 90 degree bend.
- G. The inside radius of bends in conduit shall be:
 - 1. 6 times the internal diameter for 2" or less.
 - 2. 10 times the internal diameter for greater than 2".
- H. With prior HAS/IT APPROVAL. For Backbone and riser conduit runs ONLY (2" to 4"), a special LBD conduit (Crouse-Hinds or approved equal) may be used for CMU penetration where a swept 90 will not work. LBD condulets are designed for communications cable installation to maintain bend radius requirements.
- I. A measured pull tape shall be placed in all installed conduit with pull strength of 200 pounds.
- J. Any single conduit run extending from a Telecommunication Room shall not serve more than one outlets.
- K. All communications conduits shall be identified with color coded orange tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-box locations) with the origination and destination location.

Example: IDF.AMDF > CAM.1023

- L. Conduit shall be reamed to eliminate sharp edges and terminated with an insulated throat bushing along with a screw on bushing and/or grounding bushing.
- M. Conduit protruding through the floor shall be terminated at a minimum of 4 inches above the floor surface.
- N. All stubbed conduit ends shall be provided with a ground bushing.
- O. All conduit penetrations shall be provided with the proper conduit sleeves.
 - 1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
 - 2. Sleeves shall be installed in the communications room floor or ceiling a minimum of six inches on center from the wall.
 - 3. Conduit floor sleeves shall be spaced to allow space for insulated ground bushing for cable protection.
 - 4. Shall be installed in a single tier or row from left to right horizontally.
If two tiers or rows are required, the conduits shall be staggered minimum of 2 inches between tiers.
 - 5. Cable support anchors shall be installed 18 to 24 inches above the sleeves.
- P. All cable (horizontal, riser, or backbone) wall or ceiling penetrations shall be provided with the proper conduit sleeves.
 - 1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
 - 2. Sleeves shall be installed in the floor or ceiling a minimum of two to four inches on center from the wall.
 - 3. Sleeves shall be installed in the walls at a minimum of two inches extended on each side of the wall.
 - 4. Cable floor, ceiling, and wall sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.
 - 5. Shall be installed in a single tier or row from left to right horizontally.
 - 6. If two tiers or rows are required, the conduits shall be staggered minimum of 2 inches between tiers.
 - 7. Cable support anchors shall be installed 18 to 24 inches above the sleeves.
- Q. All conduit and cabinet entrances shall be sealed with an approved, re-enter able sealant material to prevent ingress of water, dust or other foreign materials.
- R. Conduit shall not be embedded in the required fire protective covering of a structural member that is to be individually encased in accordance with Building Officials and Code Administrators International, Inc. (BOCA).
- S. Install all exposed conduit parallel or perpendicular to lines of existing construction and grouped together where possible, without interfering with use of premises or working areas. Prevent safety hazards and interference with operating and maintenance procedures.
- T. ALL Conduit Sizing and supports:
 - 1. Support conduit 2 inches and larger at 10 feet on center maximum, and conduit less than 2 inches {1½ inch and smaller} at eight feet on center maximum.
 - 2. Fasten 1½ inch and smaller conduit to concrete, masonry or steel with either one-hole malleable iron conduit straps, or "Korn" clamps, or U-bolts; for larger diameters, use two-hole straps. Use "clamp backs" for strapping conduits to planar surfaces.
 - 3. Multiple runs shall be supported on channel adequately secured to walls or hung from structure above with conduits fastened to channel with clamps designed for the purpose.
 - 4. When installation requires trapeze/rack support minimum 3/8 inch all thread shall be used.
 - 5. When installation requires a single 1-inch conduit ¼ inch all thread shall be used. No hanger wire for any installation.

6. When installation requires single conduit greater than 1 inch, 3/8 inch all-thread shall be used.
 7. Cable fill rates should not exceed 40% of the cross-sectional area of the installed conduit.
- U. Horizontal Conduit Routes:
1. Horizontal (station) conduit is defined as the conduit run between the communications outlet and the cable tray or communications room as indicated on Drawings.
 2. Each horizontal conduit run shall be a one-inch metallic conduit and shall be home run from each communications outlet box to the equipment room, terminating equipment or cable tray, as indicated in Drawings.
 3. Each single horizontal conduit run shall be provided with a junction or pull box every 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered to be two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with the offset as described herein is considered a 90-degree bend.
 4. Each dual horizontal conduit run shall be provided with a junction or pull box every 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with an offset as described herein is considered a 90-degree bend. The quantity of conduits entering the junction or pull box shall equal the number of conduits exiting the junction or pull box.
 5. Each terminating (outlet end) conduit connection shall be provided with the proper connecting insulated bushing or fitting.
 6. Each originating end (communications room end) shall be provided with the proper connecting insulated ground bushing and properly bonded to ground.
 7. If flexible conduit is required install must not be longer than 7 feet and must have HAS/IT approval prior to installation.
- V. Horizontal conduit entrance in communications rooms – wall entry
1. Horizontal conduits shall enter the communications room wall 12 to 18 inches above the top of the cable tray. Maintain cable bend radius with supporting device as required.
 2. Conduit wall stubs shall be spaced in increments equal to the conduit outside diameter (OD) from each other.
 3. All conduit wall stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
 4. Conduit crossovers are not permitted.
- W. Horizontal conduit entrance in communications rooms – ceiling entry
1. Horizontal conduits shall enter or be extended from the equipment room ceiling 12 to 18 inches above the top of the cable tray.
 2. Ceiling conduit stubs shall be spaced in increments equal to the conduit OD from each other.
 3. All ceiling conduit stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
 4. Conduit crossovers are not permitted.
- X. Horizontal conduit entrance in communications rooms – floor entry
1. Horizontal conduits shall enter the communications room floor two inches to four inches on center from the wall and shall be stubbed 4 inches AFF.
 2. Conduit floor stubs shall be spaced in increments equal to the conduit OD from each other.
 3. Conduit crossovers are not permitted.
- Y. Horizontal conduit to cable tray
1. No horizontal conduit runs shall be attached to the cable tray in any fashion.

2. Conduit terminating end shall be self-supporting above the cable tray side rail. Not attached. Minimum of 6 inches above the cable tray and not to exceed 12 inches above the cable tray.
- Z. Horizontal Junction/Outlet Boxes
1. Each horizontal conduit shall be terminated into an outlet box.
 2. Each outlet box shall be a deep four-inch square junction box with a minimum of two one-inch knockouts on each of the sides.
 3. Each conduit home run shall be provided with a deep 4 11/16" inch square junction box (w/cover) at 100-foot intervals and six inches above each ceiling and wall intersection.
- AA. Backbone/Riser conduit entrance in communications rooms – wall entry
1. BB/Riser conduits shall enter the communications room wall a minimum of 24 inches above the top of the cable tray.
 2. Conduit wall stubs shall be spaced in increments to equal the conduit OD from each other.
 3. BB/Riser conduits shall be installed in a single tier or row from left to right horizontally.
 - a. If two tiers or rows are required the conduits shall be staggered between tiers.
 - b. No more than two tiers or rows are permitted.
 4. All conduit wall stubs shall be extended to and over the cable tray to access cable tray pathway.
 5. All BB/riser conduit stubs shall be provided with the proper universal dropout/ waterfall cable exit runway, which shall be supported by and mounted to channel strut.
 6. Conduit crossovers are not permitted.
- BB. Backbone/Riser conduit entrance in communications rooms – floor entry
1. BB/Riser conduits shall enter the communications room floor two inches to four inches on center from the wall and shall stub up six inches AFF.
 2. Conduit floor stubs shall be spaced in increments to equal the conduit OD from each other.
 3. BB/Riser conduits shall be installed in a single tier or row from left to right horizontally.
 - a. If two tiers or rows are required the conduits shall be staggered between tiers.
 - b. No more than two tiers or rows are permitted.
 4. Exiting cable shall be extended to the bottom of the cable tray and be provided with cable support anchors and secured with supporting hardware every six inches above the conduit bushings.
 5. Conduit floor stubs shall be extended 6 inches from wall on center and 6 inches above AFF.
 6. The BB/riser cable shall be extended in the cable tray to the terminating equipment, as noted in the Drawings.
 7. Conduit crossovers are not permitted.

3.3 CABLE TRAY INSTALLATION

- A. Cable tray shall be supported as follows:
1. Where tray is suspended above equipment cabinets, it shall be supported by a Trapeze type hanger and per manufacture instructions. In all other applications, uni-strut trapeze type hangers affixed to the structure above via minimum 3/8-inch threaded rod shall support the tray.
 2. Threaded rod shall be fitted with a 6-inch long tube where it resides in cable tray to protect cables.
 3. Minimum of 12 inches of vertical clearance above all cable tray.
- B. Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.

- C. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.
- D. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2-2006 guidelines, or in accordance with manufacturer's instructions.
- E. A support must be place within 24 inches on each side of a connection or fitting.
- F. Maintain a minimum of 12 inches of clearance above cable tray for cable installation. Maintain a minimum of 3 inches between ceiling tile and bottom of cable tray support.
- G. Cable tray installation will be completed in one continuous run with no separations between sections.
- H. Vertical cable or ladder racks shall be used to route cable up and down the wall.
- I. Dropout/Water Fall of the same make and size of the cable tray shall be used to route cables in or out of the tray.
- J. Matted "T" and elbows shall be used of the same make and size for all interchanges and directional changes

3.4 JUNCTION BOX/PULL BOX INSTALLATION

- A. Pull boxes shall be installed in sections of conduit that are 100 feet in length, or that contain more than two 90-degree bends.
- B. A pull box shall NOT be used in lieu of a conduit bends.
- C. All pull boxes shall be installed in an easily accessible location with unobstructed entry to the pull box access panel.
- D. Pull boxes 6"x 6" or larger shall be supported on all four corners in such a manner that the cable running through does not support the pull box or conduit attached to the pull box.

3.5 CABLE HOOK INSTALLATION (J-HOOKS)

- A. Cable hook systems must be pre-approved by HAS/IT prior to installation.
- B. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.
- C. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of three.
- D. Spring steel cable hooks shall be capable of supporting a minimum of 100 pounds with a safety factor of three where extra strength is required.
- E. Cable Hook spacing maximum four feet on center.
- F. Maintain maximum cable sag between cable hooks of 12 inches.
- G. Do not fill cable hook greater than manufacturer recommended guidelines.

3.6 FIRESTOPPING MATERIAL INSTALLATION

- A. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instruction, and product carton instruction for installation.
- B. Verify substrate conditions are acceptable for product installation in accordance with manufacturer's instructions.
- C. Install fire stopping to comply with performance requirements specified herein.
 - 1. Install fire stopping to comply with listed fire rated assemblies in accordance with ASTM and UL requirements
 - 2. Installer shall be trained and approved by the manufacturer
- D. Protect installed products from damage during construction operations until completions.
- E. Inspection: Code official or building inspectors to review proper installation using manufacturer guidelines.

END OF SECTION 27 0528

SECTION 270553
IDENTIFICATION AND LABELING OF COMMUNICATIONS INFRASTRUCTURE

PART 1 - INTRODUCTION

1.1 GENERAL

- A. As the Houston Airport System (HAS) continues to develop both its private and commercial interests, it is essential that an effective telecommunications infrastructure be developed and maintained to ensure the support of any and all services which rely on the electronic transport of information. To effectively administer these assets requires a disciplined effort that begins with a systematic practice and procedure for capturing useful data regarding inventories that might be conducted at any point during the lifecycle of a project.

1.2 OBJECTIVE

- A. The objective and intent of this standard is to provide uniform GIS inventory and documentation practices/guidelines for any person or party directly involved with data collection, administration and/or accountability of the HAS IT telecommunications infrastructure or related systems.

1.3 INTENDED USE

- A. Any designer, consultant or engineering entity contracting with the Houston Airport System to inventory/document the telecommunications physical and network configurations will need to refer to this document for clarification regarding standard operating procedures. The guidelines given here provide for effective documentation of the HAS telecommunications network. The result of following this standard will be a telecommunications infrastructure that is well documented and easily managed by the administrator.
- B. Note: For specific criteria concerning GIS/GPS datum, refer to the OASIS Standards document maintained by direction under the HAS Planning Design and Construction department. Said datum is not specific to the Information Technology department and thus will not be replicated here.

1.4 LIFE OF THE STANDARD

- A. This standard is a living document. The criteria contained in this standard are subject to revision without notice, as warranted by advances in administration techniques related to telecommunications technology.
- B. This manual is the property of the Houston Airport System. The contents of this manual are proprietary and should not be copied or disclosed without prior written permission of the Houston Airport System. Any variation from the standards in this manual should be addressed by the Houston Airport System IT GIS contact listed below for approval prior to implementation on a project

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1.5 GENERAL

- A. This standard specifies the GIS inventory and documentation requirements for the Houston Airport System IT Telecommunications Infrastructure, Network Engineer and associated information databases. Areas of the infrastructure and/or databases to be inventoried, administered, monitored or maintained include:
1. Terminations for the telecommunications media located in work areas, telecommunications closets, equipment rooms, and entrance facilities;
 2. Equipment/devices hosting physical terminations;
 3. Telecommunications media (cable) between terminations;
 4. Pathways (spans) between terminations that contain the media;
 5. Spaces (structures) where terminations are located;
 6. Bonding/grounding as it applies to telecommunications;
 7. Geophysical plant networks i.e., manhole, handhole, pullbox, cabinet, pedestal, building access points;
 8. Splice enclosures.
 9. NOTE: Whereas this document provides an outline and overview of the GIS documentation process, the following Telecommunications Infrastructure Specifications for the Houston Airport System should be referenced for detailed administrative requirements:
- B. This standard also specifies requirements for the collection, organization, and presentation of as-built data.
- C. In addition to providing requirements and guidelines for a traditional paper-based documentation system, this standard will serve as the reference for all associated computer-based administration tools.
- D. Contracting parties, by this standard, are required to attend an HAS-IT coordination meeting prior to commencement of any documentation effort; the scope of work and project expectations will be discussed at length. You will be given additional direction as required and any useful maps, diagrams, numerical sequences, etc. will be provided to you at this time.

1.6 REFERENCES

- A. The latest published version at the date of contract applies to all references. Related Documents include all Drawings and General Provisions of the Contract. In Conflict between contract documents, the most stringent will be applied.
- B. Related Specifications: Use these Specifications for all related work not specifically covered in this specification.
 - 1. Section 270526: Telecommunication Grounding and Bonding
 - 2. Section 270528: Interior Communication Pathways
 - 3. Section 270543: Exterior Communication Pathways
 - 4. Section 270553: Identification and Labeling of Communication Infrastructure
 - 5. Section 271100: Communication Cabinets and Equipment Rooms
 - 6. Section 271300: Backbone and Riser Media Infrastructure
 - 7. Section 271500: Horizontal Media Infrastructure
 - 8. Section 272100: Data Communication Network Equipment
 - 9. Section 272200: PC, Laptop, Servers and Equipment
 - 10. Section 275113: Audio Communication System
 - 11. Section 281300: Access Control System
 - 12. Section 232313: Video Surveillance Control and Management System

1.7 DEFINITIONS

- A. This section contains definitions of terms, acronyms, abbreviations, and formats that have special technical meaning or that are unique to the technical content of this standard.
- B. For the purposes of this standard, the following definitions apply:
 - 1. Assignment
 - a. A unique designation assigned to a person who is expected to use the circuit, equipment, service, etc., serving a particular work area. Examples of an assignment: telephone number, a name, a circuit number or a logical address.
 - 2. Backbone
 - a. Network of copper and fiber connections between termination panels/switches.
 - 3. Cable
 - a. An assembly of one or more copper conductors or optical fibers within an enveloping sheath, constructed so as to permit use of the conductors singly or in groups.
 - 4. Campus
 - a. The buildings and grounds have legal contiguous interconnection. (TIA)
 - 5. Equipment
 - a. Generally, an endpoint for cable lengths; any hardware device/component. Used to terminate cable for cross-connection or interconnection to other cables or devices.
 - 6. Grounding electrode conductor
 - a. The conductor used to connect the grounding electrode to the equipment grounding conductor and/or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system.
 - 7. Handhole (HH)
 - a. A structure similar to a small maintenance hole in which cable can be pulled, but not large enough for a person to fully enter to perform work.
 - 8. Identifier
 - a. An item of information that links a specific element of the telecommunications infrastructure with its corresponding record. (TIA)
 - 9. Linkage
 - a. A connection between a record and an identifier or between records.(TIA)

10. Location
 - a. A position occupied or available for occupancy within a site or infrastructure network.
11. Manhole (MH)
 - a. A vault located in the ground or earth as part of an underground duct system and used to facilitate placing, establishing connections and maintenance of cables as well as placing associated equipment, in which it is expected that a person will enter to perform work. (TIA).
12. Outlet box (telecommunications)
 - a. A metallic or nonmetallic box mounted within a floor, wall or ceiling and used to hold telecommunications outlet/connectors or transition device. (TIA)
13. Outlet / connector (telecommunications)
 - a. A connecting device in the work area on which horizontal cable or outlet cables terminates. (TIA)
14. Pathways
 - a. A raceway, conduit, sleeve, or exposed location, for the placing of telecommunications cable that links telecommunications spaces together.
15. Record
 - a. The permanent documentation of installed telecommunications infrastructure obtained from as-builts.
16. Record drawing (as-built)
 - a. The documentation of measurements, location, and quantities of material work performed. May be in the form of marked up documents or other work order forms.
17. Report
 - a. A presentation of a collection of information from various records.
18. Site
 - a. Spatial location of an actual or planned structure or set of structures.
19. Span
 - a. A raceway, conduit, sleeve, or exposed location, for the placing of telecommunications cable that links telecommunications spaces together.
20. Splice
 - a. A joining of conductors meant to be permanent. (TIA)
21. Splice box
 - a. A box, located in a pathway run, intended to house a cable splice.(TIA)
22. Splice enclosure
 - a. A device used to protect a cable or wire splice.(TIA)
23. Structure
 - a. Generally an endpoint for span lengths; i.e., manhole, handhole, cabinet, junction box, pedestal, building access point, communications rooms, work areas.
24. Structure unit
 - a. A component of the structure; usually housing equipment i.e., cabinet, rack.
25. Telecommunications
 - a. Any transmission, emission, or reception of signs, signals, writings, images, and sounds; that is, information of any nature by cable, radio, optical or other electromagnetic systems. (TIA)
26. Telecommunications infrastructure
 - a. The components (telecommunications spaces, cable pathways, grounding, wiring and termination hardware) that together provide the basic support for the distribution of all telecommunications information.
27. Telecommunications media
 - a. Wire, cable, or conductor used for telecommunications.
28. Telecommunications space
 - a. Areas used for the installation and termination of telecommunications equipment and cable, e.g., telecommunications closets, work areas, false ceilings, and manholes/handholes.

- 29. Termination position
 - a. A discrete element of termination hardware where telecommunications conductors are terminated.
- 30. Work area; (work station)
 - a. A building space where the occupants interact with telecommunications equipment.(TIA)

1.8 DOCUMENTATION CONCEPTS

- A. This section describes the concepts of identifiers, records, linkages among records, and presentation of information necessary to administer infrastructure cable, spans and structures.

1.9 IDENTIFIERS

- A. An identifier is assigned to an element of the telecommunications infrastructure to link it to its corresponding record. Identifiers shall be marked at the elements to be administered.
- B. Identifiers used to access record sets of the same type shall be unique. For example, each identifier for each one of the set of cable records shall be unique. Unique identifiers across all types of telecommunications records are mandatory. For example, no cable record identifier should be identical to any pathway record identifier.
- C. Labeling is the marking of an element of the telecommunications infrastructure with an identifier and (optionally) other relevant information. Labeling shall be accomplished in either of two ways: separate labels may be securely affixed to the element to be administered, or the element itself may be marked.

1.10 RECORDS

- A. A record is a collection of information about or related to a specific element of the telecommunications infrastructure.
- B. Elements identified as required information and required linkages shall constitute the minimum requirements for these records. Specific information and other linkages suggest additional elements that may be useful to the administrative system, such as cable length.
- C. Telecommunications records are typically used in conjunction with other records. For example, a user record or assignment may contain an identifier to the record of the cable that serves an individual's workspace. Conversely, a cable record may also contain an identifier for a user record or assignment.
- D. By this standard, the Houston Airport System utilizes AutoCAD and ArcGIS as the software platforms by which all telecommunications infrastructure records and linkages are recorded and maintained.

1.11 RELATIONSHIPS

- A. Relationships are the logical connections between identifiers and records. The records for infrastructure elements shall be interlinked. For example, in a cable record, termination port identifiers point to specific termination port records that contain additional information about each of the cable termination ports.

1.12 ASSIGNMENT

- A. An "assignment" is a specific term of reference that allows the association of the end location, cable pairing record or termination port record with additional information. For example, an

assignment such as a telephone number or circuit number can associate a user with elements of the telecommunications infrastructure. This aids in troubleshooting by identifying both the physical and logical connectivity from a single circuit assignment.

1.13 PRESENTATION OF INFORMATION

- A. A typical documentation system includes labels, records, reports, drawings, and work orders. Reports compile and present information found in the records. Graphical information regarding the relationship of the telecommunications infrastructure to other infrastructures within the campus or site is presented in drawing format. Work orders document the operations needed to implement changes affecting the telecommunications infrastructure.
- B. Reports present information selected from the various telecommunications infrastructure records. Reports may be generated from a single set of records or from several sets of interlinked records.
- C. Drawings are used to illustrate different stages of telecommunications infrastructure planning and development. Generally, conceptual and installation drawings supply input to the record drawings that graphically document the telecommunications infrastructure. These record drawings as well as some equipment schedules and installation drawings (i.e., rack layouts) become part of the administration system documentation.
- D. drawings (i.e., one-line or riser diagrams) are used to illustrate the proposed design intent. They do not typically include all telecommunications infrastructure elements or identifiers and do not necessarily become part of the administration documentation.
- E. Installation or bid drawings are used to document (graphically) the telecommunications infrastructure to be installed. They should illustrate relevant infrastructure elements and may also describe the means of installation. Identifiers may or may not be included on the drawings.
- F. Record drawings (as-builts) graphically document the installed telecommunications infrastructure through floor plans, elevation, and detail drawings. These drawings may differ from installation drawings because of changes and specific site conditions. Key elements of the telecommunications infrastructure shall have identifiers assigned. The span/structure and wiring portions of the infrastructure each may have separate drawings if warranted by the complexity of the installation or the scale of the drawings.
- G. ESRI (ArcGIS) formatted feature class and feature class layers graphically depict data in a spatial environment and are linked via physical relationship protocols established by the administrator through the utilization of software engineered towards GIS applications.

1.14 WORK ORDERS (SYMANTEC)

- A. Work orders document the actions needed to implement changes affecting the telecommunications infrastructure as it was actually installed. The changes may involve several telecommunications components as well as other related systems. The Documentation Team utilizes Symantec software as its change-management notification platform. Typical Symantec tickets document actions such as moving a patch cord, installing a conduit, cross-connect or relocating an outlet box. A Symantec ticket may involve structures, spans, cable, splices, terminations, or grounding, either individually or in combination. A Symantec ticket should list both the personnel responsible for the physical action and those responsible for updating various portions of the documentation to assure its accuracy. Prior to commencement of an action that would result in a change to any telecommunications infrastructure component or related system; a Symantec ticket should be submitted in accordance with departmental and operational requirements.

1.15 SUMMARY

- A. This section has presented basic concepts of documentation for the Houston Airport System Telecommunications Infrastructure. The sections that follow specify the administration of each of the components of the infrastructure in greater detail.

1.16 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations.

PART 2 – PRODUCTS

PART3 – EXECUTION

3.1 DATA COLLECTION AND ADMINISTRATION CONCEPTS

- A. This section describes the documentation of assets within the **administrative** jurisdiction of the Houston Airport System - Public Safety and Information Technology department. As changes are made to the assets, affected labels, records, reports and drawings shall be updated or revised.
- A. The following outline assumes that the contracting parties understand the GIS/GPS datum specifications and requirements as provided in the OASIS standards. Further, that the equipment to be used towards gathering the data has been configured accordingly.

3.2 STRUCTURES

- A. Standard structures
 1. Manhole
 2. Handhole
 3. Pullbox
 4. Cabinet (Pole Mounted, Pedestal)
 5. Building Access
 6. Dog House
 7. Remote Location
 8. Entrance Facility
 9. Workspace
 10. Main Distribution Frame (MDF)
 11. Building Distribution Frame (BDF)
 12. Intermediate Distribution Frame (IDF)
 13. Point of Presence (POP)
 14. Pathway Transition
 15. Aerial Pole
- B. Identification
 1. Each Structure has been assigned a unique GIS database identifier. This identifier serves as

- a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All structure identifiers follow a specific schema; new structures must be identified accordingly. In the event that a determination cannot be made regarding the identification of a structure, please contact an HAS IT GIS representative prior to documenting.
 3. All structures are identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
 4. Airport Campus Characters:
 - a. IAH: I
 - b. HOU: H
 - c. EFD: E
 5. Asset Designation Character:
 - a. Technology: T
 6. Feature-Category Characters:
 - a. Structure: S
 - b. Pathway: P
 - c. Equipment: E
 - d. Cable: C
 7. Numerical Range:
 - a. 0000 – 9999
 8. Example:
 - a. ITS0054 (IAH Structure), HTS0054 (HOU Structure), ETS0054 (EFD Structure)
 9. Manhole Numerical Range:
 - a. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

C. Labeling

1. Labeling should follow the identification schema and further be accomplished via an approved method described below.
2. Newly constructed structures (manhole, handhole, pullbox, cabinet) will require that their identifiers be etched onto the lid or affixed with an appropriate label material. Manholes and handholes should be stamped on the lid itself, as well as the metal ring/material surrounding the opening; or the concrete foundation (topside). Utilize an appropriate chisel or stamp, or labeling device to accomplish the task.
3. The Technology Infrastructure group does not maintain the specification for labeling newly constructed structures (dog house, remote location, entrance facility, workspace, MDF, BDF, IDF, POP, Pole). These should be placarded according to current HAS Infrastructure specification. The Technology Infrastructure GIS identifiers (described in the previous paragraphs) relevant to these spaces and locations are preserved for GIS database record keeping purposes only. Contact an HAS Infrastructure representative for clarification on physical labels for architectural spaces.
4. Required Fields. Each structure requires that specific data be collected per unit. GPS equipment should be formatted to account for this information:
 - a. TELECOM_ID
 - b. COORD_X
 - c. COORD_Y
 - d. COORD_Z
 - e. AIRPORT
 - f. AGENCY
 - g. LID_TYPE
 - h. DEPTH_INCH
 - i. SPLICE_CLOSURE
 - j. SLACK_LOOP
 - k. GROUNDING

- I. COMMENTS
 - m. BUILDING_NAME
 - n. LEGACY_ID
 - o. STRUCTURE_TYPE
 - p. STRUCTURE_SUBTYPE
 - q. HAS_LEVEL
 - r. LID_SIZE
 - s. PROJECT
 - t. COLLECTION_DATE
 - u. LID_SHAPE
 - v. LID_MATERIAL
 - w. PROJECT_CLASS

- D. GPS
 - 1. Each manhole should be recorded as follows:
 - 2. Single shots; taken on-center. Offset shots are acceptable for manholes not available to satellite coverage but these shots must be coordinated with an HAS-IT GIS contact prior to.

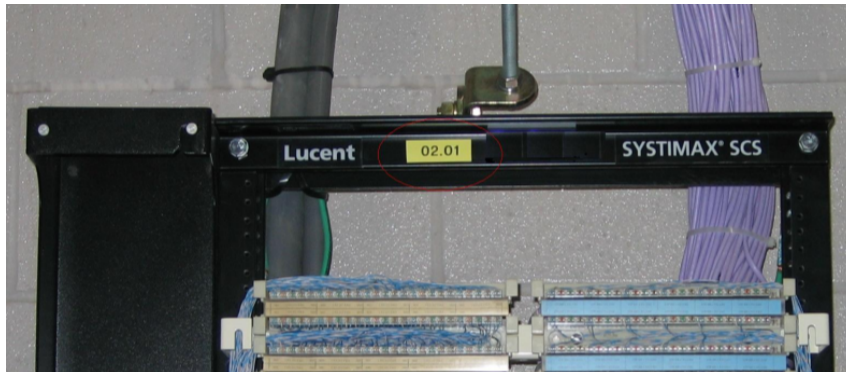
- E. Supporting documentation deliverables
 - 1. Additional documentation records are required to support GPS data. The documentation is as follows:
 - 2. Manholes and Handholes only
 - a. Digital photos – top (north to top of photo), north wall, west wall, south wall, east wall; for manholes not true to cardinal compass points adjust call-outs as necessary.
 - b. AutoCAD – butterfly diagram of manhole depicting pathway orientation, conduit layout, innerduct configurations, cabling locations, and cabling counts for each manhole unit in both .dwg 2010 or higher and .pdf formats; (See manhole AutoCAD butterfly exhibit; see also the OASIS standards for IT specific AutoCAD layering).
 - c. Video – 360 degree imagery of interior; .mpg format.
 - 3. Communication Room
 - a. AutoCAD – floorplan (where applicable) layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit).
 - 4. Spatial Data Deliverables
 - a. The entire manhole inventory should be delivered separately in ArcGIS feature class (version 10) format along with any records outlined in the ‘Supporting Documentation’ paragraph. This feature class (STRUCTURE) should contain the attribute values from the ‘Required Fields’ paragraph.
 - 5. Special Instructions
 - a. None

- 3.3 CABINETS/RACKS
 - A. Identification
 - 1. Each cabinet/rack has been assigned a unique campus identifier. All structure identifiers follow some specific schema; new structures must be identified accordingly. In the event that a determination can not be made regarding the identity of the structure, please contact the HAS IT GIS representative prior to documenting.
 - 2. All cabinets are identified through a numerical range specific to its respective campus and should be prefixed with ‘PC’ (pedestal cabinet) or ‘PM’ (pole mounted cabinet). The ranges are as follows:
 - 3. Example:
 - a. ITS0054.02.01
 - 1) Translation: Cabinet or Rack in Room (Structure) ITS0054, row 02, column or position 01.

- b. ITS0054.BB01
 - 1) Translation: Backboard (plywood) 01 in Room (Structure) S103.1.
- 4. Note: Backboards tend to be randomly arranged within the structure and are usually not numbered according to wall orientation. Different identifiers are however assigned to each. Any one backboard could host a wide assortment of equipment; see EQUIPMENT for identifier schemas.
- 5. Note: Future expansion of rows should be a major consideration during identifier/labeling phase; numbering from low to high in the direction of any available space.

B. Labeling

- 1. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
 - a. DYMO RhinoPRO 5000 Industrial Label Maker
 - b. 3/4" Flexible Industrial Strength Nylon label tape – yellow
- 2. Labels should be affixed to the cabinet housing.
- 3. Labels should be affixed to top-center of identified structure unit. For labeling purposes only, the structure identifier can be omitted from the structure unit identifier to minimize space required for the label. It will be assumed that all structure units located in the same structure will carry the same structure identifier. Note: this is for labeling purposes only; data collection records/tables must use complete identifier including telecom structure identifier.



C. Required Fields

- 1. No Action required

D. GPS

- 1. No Action required

E. Supporting Documentation Deliverables

- 1. AutoCAD – floorplan and rackface layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit)

F. Spatial Data Deliverables

- 1. No Action require

G. Special Instructions

- 1. Structure units are visibly marked with a reference tag identifying its column and row. The telecom structure (ITS, HTS, ETS) is omitted from the reference tag but should be included in the structure unit tables. Newly placed structure units will require that their identifiers be affixed

to the cabinet face or rack frame. Utilize specified labeling device to accomplish the task.

3.4 PATHWAYS

1. Ductbank
2. Trench
3. Direct Buried
4. Cable Tray

A. Identification

1. Each Pathway has been assigned a unique GIS database identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All pathway identifiers follow a specific schema; new pathways must be identified accordingly. In the event that a determination cannot be made regarding the identification of a pathway, please contact an HAS IT GIS representative prior to documenting.
3. All pathways are identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
4. Airport Campus Characters:
 - a. IAH: I
 - b. HOU: H
 - c. EFD: E
5. Asset Designation Character:
 - a. Technology: T
6. Feature-Category Characters:
 - a. Structure: S
 - b. Pathway: P
 - c. Equipment: E
 - d. Cable: C
7. Numerical Range:
 - a. 0000 – 9999
8. Example:
 - a. ITP0054 (IAH Pathway), HTP0054 (HOU Pathway), ETP0054 (EFD Pathway)

B. Labeling

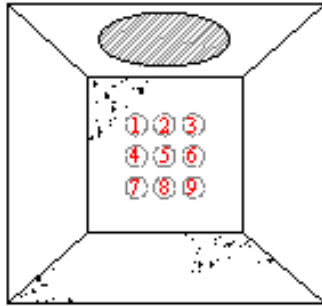
1. Pathways are identified for the purposes of GIS referencing and are linked to structure inventories but are not physically labeled per current guidelines.

C. Required Fields

1. Each pathway requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.
 - a. CONDUIT_SIZE
 - b. COMMENTS
 - c. AIRPORT
 - d. HAS_ENCASMENT
 - e. AGENCY
 - f. CONDUIT_QTY
 - g. PATH_ID
 - h. PATH_NUMBER
 - i. PATH_TYPE
 - j. END1_COORD_X
 - k. END1_COORD_Y
 - l. END1_COORD_Z
 - m. END2_COORD_X
 - n. END2_COORD_Y

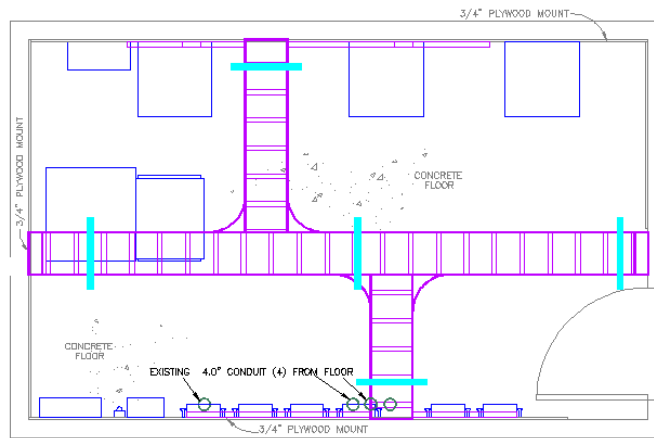
- o. END2_COORD_Z
 - p. HAS_LEVEL
 - q. COLLECTION_DATE
 - r. PROJECT
 - s. TICKET
 - t. LEGACY_ID
 - u. PATHWAY_MATERIAL
 - v. FROM_TELECOM_ID
 - w. TO_TELECOM_ID
 - x. TELECOM_ID
 - y. PROJECT_CLASS
 - z. DEPTH_END1
 - aa. DEPTH_END2
 - bb. GPS
2. Each pathway must be recorded as follows:
- a. Care should be taken to accurately locate the pathways prior to commencing with documentation.
 - b. Continuous-line shots; taken on center. Line-shots should begin and end on-center of endpoint (structure) locations.
- D. Spatial Data Deliverables
- 1. The entire pathway inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the ‘Supporting Documentation’ paragraph. This feature class (PATHWAY) should contain the attribute values from the ‘Required Fields’ paragraph.
- E. Special Instructions
- 1. No action required
- 3.5 CABLE TRAY
- A. Identification
 - 1. No requirements per current guidelines
 - B. Required Fields
 - 1. No requirements per current guidelines
 - C. GPS
 - 1. No requirements per current guidelines
 - D. Supporting Documentation Deliverables
 - 1. No requirements per current guidelines
 - E. Spatial Data Deliverables
 - 1. No requirements per current guidelines
 - F. Special Instructions
 - 1. No requirements per current guidelines
- 3.6 PATHWAY UNITS
- A. Conduit Identification
 - 1. For deliverable purposes conduits are only being depicted via AutoCAD formats; i.e. butterfly diagrams or floorplans (see Exhibits: Communication Room Exhibit, Rackface Exhibit)

2. In the outside plant environment, conduits should be identified where applicable by size, location and position relative to their endpoints (structures) i.e. handhole wall, building access point, etc.
3. Further, on manhole / handhole butterfly diagrams, OSP conduits are depicted relevant to their size, position and orientation. As a general rule, conduits are identified left-to-right and top-to-bottom as you're facing the wall to be inventoried and should be prefixed with 'CD' on the AutoCAD documents.



MANHOLE

- B. For the purposes of illustration and to be included as part of the manhole butterfly diagram draft document, each wall should identify the following:
 - C. Ductbank (Telecom Pathway Identifier for each respective manhole / handhole wall face)
 - D. Conduits (Count, Orientation)
 - E. Cabling (Telecom Cable Identifier, Cable Type, Cable Count, location within respective conduit)
- F. In the inside plant environment, conduits should be identified where applicable by position and location relative to their endpoints (telecom structures) i.e. communications rooms, vaults
- G. ISP conduits are depicted on communication-room AutoCAD layouts as to their position and orientation; and are not numbered.
- H. Example:



- I. Labeling
 - 1. Not physically labeled per current guidelines.
- J. Required Fields
 - 1. Conduit counts, and size as prescribed in the pathway sub-topic
- K. GPS
 - 1. No action required
- L. Supporting Documentation Deliverables
 - 1. AutoCAD manhole / handhole butterfly diagrams for OSP conduits and communication-room layouts for ISP conduits; (See manhole / handhole AutoCAD butterfly exhibit).
- M. Spatial Data Deliverables
 - 1. No action required
- N. Special Instructions
 - 1. See note regarding annotation above.

3.7 CABLE

- 1. Inside Plant Copper
 - 2. Inside Plant Fiber (Single-Mode, Multi-Mode)
 - 3. Outside Plant Copper
 - 4. Outside Plant Fiber (Single-Mode, Multi-Mode)
 - 5. Inside Plant Copper Coax
 - 6. Outside Plant Copper Coax
 - 7. Inside Plant Hybrid
 - 8. Outside Plant Hybrid
- A. Identification
 - 1. Each Cable has been assigned a unique GIS database identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
 - 2. All cable identifiers follow a specific schema; new cable must be identified accordingly. In the event that a determination cannot be made regarding the identification of a cable-run, please contact an HAS IT GIS representative prior to documenting.

3. All cables are identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
 - a. Airport Campus Characters:
 - 1) IAH: I
 - 2) HOU: H
 - 3) EFD: E
 - b. Asset Designation Character:
 - 1) Technology: T
 - c. Feature-Category Characters:
 - 1) Structure: S
 - 2) Pathway: P
 - 3) Equipment: E
 - 4) Cable: C
 4. Numerical Range:
 - a. 0000 – 9999
 5. Example:
 - a. ITC0054 (IAH Cable), HTC0054 (HOU Cable), ETC0054 (EFD Cable)
 6. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.
- B. Labeling
1. Labels should be affixed to all connection ends of identified cable and on any visible length at key access points, i.e. manhole, handhole cable ladder runs.
 2. "All adhesive inside/outside plant cable labels for horizontal and backbone cables shall be covered with clear heat shrink tubing"
- C. Each cable requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.
1. TELECOM_ID
 2. LEGACY_ID
 3. AIRPORT
 4. AGENCY
 5. CABLE_TYPE
 6. CABLE_COUNT
 7. FROM_TELECOM_ID
 8. TO_TELECOM_ID
 9. FROM_STRUCTURE_UNIT_ID
 10. TO_STRUCTURE_UNIT_ID
 11. FROM_EQUIPMENT_ID
 12. TO_EQUIPMENT_ID
 13. HAS_LEVEL
 14. PROJECT
 15. PROJECT_CLASS
 16. COLLECTION_DATE
 17. SYMANTEC_TICKET
 18. COMMENTS
 19. GPS
- D. OSP – continuous GPS shot between identified structures
- E. ISP – conventional GPS services are unavailable inside-plant; therefore inside-plant cabling will need to be digitized and included in the ArcGIS CABLE feature class spatial data deliverable.

- F. Supporting Documentation Deliverables
 - G. ISP Horizontal cabling (see Exhibits – iPatch SOP.pdf).
 - H. Cable testing records; .pdf format (see Exhibits – C_Cable Test Exhibit, F_Cable Test Exhibit.pdf).
 - I. Butterfly diagrams (OSP) AutoCAD format; (See AutoCAD manhole / handhole butterfly exhibit).
 - J. Spatial Data Deliverables
 1. The entire OSP cable inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the ‘Supporting Documentation’ paragraph. This feature class (CABLE) should contain the attribute values from the ‘Required Fields’ paragraph.
 2. No Spatial Data required for ISP inventory.
 - K. Special Instructions
 1. No cable testing should be conducted on any live circuit. Ensure that necessary precautions are observed to guarantee existing network integrity and no active circuits are impacted.
- 3.8 JUMPER CABLES / PATCH CORDS / CROSS-CONNECTS:
- A. Identification
 1. No action required
 - B. Labeling
 1. No action required
 - C. Required Fields
 1. Refer to iPatch SOP (see Exhibits - iPatch SOP.pdf)
 - D. GPS
 1. No action required
 - E. Supporting Documentation Deliverables
 1. ISP cabling (see Exhibits - iPatch SOP.pdf)
 - F. Spatial Data Deliverables
 1. No action required
 - G. Special Instructions
 1. No cable testing should be conducted on any live circuit. Ensure that necessary precautions are observed to guarantee existing network integrity and no active circuits are impacted.
 2. As iPatch is the administration application for these assets - all project managers, inspectors and consultants overseeing ‘new-build’ infrastructure configurations must strictly adhere to guidelines specified in the iPatch SOP (see Exhibits - iPatch SOP.pdf). Further, you must contact an iPatch database administrator directly to coordinate the data collection and documentation-deliverable evolution.
 3. Bulk import of key iPatch modeling components can be facilitated by utilization of a specifically formatted spreadsheet (see Exhibits - iPatch Bulk Import.xls).
 4. Updates/changes to fiber patching can be facilitated by utilization of a specifically formatted cut-sheet (see Exhibits – Fiber Patching Cut Sheets.xls).
- 3.9 EQUIPMENT
- A. Termination Point

1. Patch Panel
2. Network Switch
3. 110 Block
4. Splice Enclosure
5. Cable Transition
6. EFSO Button
7. Copper Modem
8. Tap
9. Camera

B. Identification

1. All Equipment has been assigned a unique GIS database identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All equipment identifiers follow a specific schema; new equipment must be identified accordingly. In the event that a determination cannot be made regarding the identification of a piece of equipment, please contact an HAS IT GIS representative prior to documenting.
3. All equipment is identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
4. Airport Campus Characters:
 - a. IAH: I
 - b. HOU: H
 - c. EFD: E
5. Asset Designation Character:
 - a. Technology: T
6. Feature-Category Characters:
 - a. Structure: S
 - b. Pathway: P
 - c. Equipment: E
 - d. Cable: C
7. Numerical Range:
 - a. 0000 – 9999
8. Example:
 - a. ITE0054 (IAH Equipment), HTE0054 (HOU Equipment), ETE0054 (EFD Equipment)

C. Labeling

1. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
 - a. DYMO rhinoPRO 5000 Industrial Label Maker
 - b. 3/4" Flexible Industrial Strength Nylon label tape - yellow
2. Labels should be affixed to the splice enclosure housing.
3. Label placement should be affixed to or as near to equipment as possible.

D. Required Fields

1. All equipment requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.
 - a. EQUIPMENT_ID
 - b. TELECOM_ID
 - c. SYMANTEC_TICKET
 - d. CABLE_ID
 - e. TELECOM_CABLE_ID
 - f. LEGACY_CABLE_ID
 - g. AIRPORT
 - h. AGENCY
 - i. PROJECT

- j. PROJECT_CLASS
 - k. COLLECTION_DATE
 - l. COMMENTS
 - m. LEGACY_ID
 - n. EQUIPMENT_TYPE
 - o. HAS_LEVEL
- E. GPS
- 1. No action required for ISP equipment
 - 2. Each splice enclosure (OSP) should be recorded as follows:
 - 3. Single shots; taken on-center. Offset shots or other means of location are acceptable for splice enclosures not available to satellite coverage but these shots or options must be coordinated with an HAS-IT GIS contact prior to.
- F. Supporting Documentation Deliverables
- 1. AutoCAD – one-line diagram of ACCESSIBLE for splice enclosures depicting cable identifiers, connections and cable counts for each splice enclosure in both .dwg 2010 or higher and .pdf formats; (See AutoCAD splice enclosure exhibit).
 - 2. AutoCAD – rackface layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit).
- G. Spatial Data Deliverables
- 1. The entire equipment inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the ‘Supporting Documentation’ paragraph. This feature class (EQUIPMENT) should contain the attribute values from the ‘Required Fields’ paragraph.
- H. Special Instructions
- 1. Do not attempt to open a splice enclosure that appears to be in a fragile state or does not provide for ready access (sealed). Note in ‘comments’ field that the enclosure was inaccessible.
 - 2. Do not move, adjust ‘live’ equipment in order to identify or label. Ask for assistance from qualified HAS Technology Infrastructure personnel.
 - 3. Do not disconnect cabling in order to identify or label. Ask for assistance from qualified HAS Technology Infrastructure personnel.
- 3.10 OUTLETS
- A. Identification
- 1. Each outlet-faceplate is identified specific to its servicing IDF; regardless of the number of outlets within a given location. All outlet-faceplate ports are labeled to correspond with the servicing IDF panel port. Note: These space identifiers are architectural identifiers, and are designated by reference to the HAS Infrastructure schema for identifying building spaces. This is not a GIS Technology Infrastructure database identifier.
 - 2. Example Outlet-Faceplate Identifier:
 - a. S103.1
 - 1) Translation: Outlet serviced by IDF S103.1
 - 3. In the event that a determination cannot be made regarding the identity of the outlet, please contact the HAS IT GIS representative prior to documenting.
 - 4. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

B. Labeling

1. Outlet label placement 2-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right.



2. Outlet label placement 3-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right.
3. Outlet label placement 4-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Follow 3-port example.



4. Outlet label placement 6-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Any mid-faceplate ports will require an adhesive label - servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports

should be identified left-to-right. These types of outlets are ‘Non-Standard’.

- C. Required Fields
 - 1. No action required
- D. GPS
 - 1. OSP – No GPS action required
 - 2. ISP – No GPS action required
- E. Supporting Documentation Deliverables
 - 1. Additional documentation records are required to support iPatch data. The documentation is as follows:
 - 2. AutoCAD – floorplan (where applicable) depicting outlet locations; (See AutoCAD communications room exhibit).
- F. Spatial Data Deliverables
 - 1. No action required
- G. Special Instructions
 - 1. Outlets are visibly marked with a reference tag indicating the outlet identifier. Additionally any port associated to the outlet is identified with a port number related specifically back to its respective servicing equipment. Newly placed outlets will require that their identifiers be affixed to the outlet face. Utilize specified labeling device to accomplish the task.

3.11 DOOR CONTACTS

- A. Identification
 - 1. Each door-contact sensor (without card-reader) is identified by an alpha-numeric sequence specific to its location. All door-contact identifiers are coded with building or complex character, followed by level character, followed by numerical sequence character, followed by ‘CCM’ designation. ‘CCM’ is an acronym for ‘Control Contact Monitoring.’
 - 2. Example Outlet-Faceplate Identifier: B-2057CCM
 - a. Translation:
 - b. B (building/complex character) Terminal B
 - c. 2 (level character) Level 2
 - d. 057 (numerical sequence character) Contact # 057
 - e. CCM (CCM designation) Control Contact Monitoring
 - 3. In the event that a determination cannot be made regarding the identity of a door contact, please contact the HAS IT Project Manager prior to documenting.
 - 4. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT Project Manager prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.
- B. Labeling
 - 1. Door-contacts (without card-reader) require identifier plates per ‘Special Instruction’ specification below
- C. Required Fields
 - 1. TBD
- D. GPS
 - 1. OSP – No GPS action required
 - 2. ISP – No GPS action required

- E. Supporting Documentation Deliverables
 - 1. AutoCAD floorplans indicating door contact location including label plate identifier annotation
- F. Spatial Data Deliverables
 - 1. No action required
- G. Special Instructions
 - 1. Install Black Lexan Label Plate: sized 1 ½" X 4", black background, white lettering and Door Alarm Identifier engraved (i.e. B-2057CCM). Locate plate on door frame above contact. Clean door frame prior to placement. Affix with 3M double-sided tape.
 - 2. Provide paper and electronic copies (.pdf format) of all Electronic Lock Permits and Submittal Documents for any door requiring City of Houston door lock permit to the HAS IT Project Manager prior to Acceptance Testing.

3.12 CARD READERS

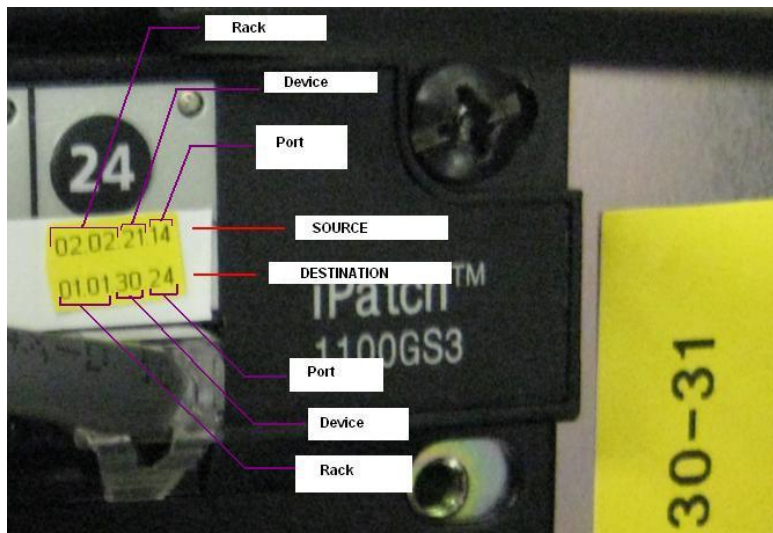
- A. Identification
 - 1. Each electronic lock is identified by an alpha-numeric sequence specific to its location. All electronic lock identifiers are coded with building or complex character, followed by level character, followed by numerical sequence character.
 - 2. Example Outlet-Faceplate Identifier:C-1015
 - 3. Translation:
 - a. C (building/complex character) Terminal C
 - b. 1 (level character) Level 1
 - c. 015 (numerical sequence character) Lock # 015
 - 4. In the event that a determination cannot be made regarding the identity of a door contact, please contact the HAS IT Project Manager prior to documenting.
 - 5. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT Project Manager prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.
- B. Labeling
 - 1. Electronic locks require identifier plates per 'Special Instruction' specification below
- C. Required Fields
 - 1. TBD
- D. GPS
 - 1. OSP – No GPS action required
 - 2. ISP – No GPS action required
- E. Supporting Documentation Deliverables
 - 1. AutoCAD floorplans indicating card reader location including label plate identifier annotation
- F. Spatial Data Deliverables
 - 1. No action required
- G. Special Instructions
 - 1. Install Black Lexan Label Plate: sized approximately 3 ¼" X 5 ½", black background, white lettering and Card Reader Identifier engraved (i.e. C-1015). Affix plate to single-gang cabinet with 5/32" screws.
 - 2. Provide paper and electronic copies (.pdf format) of all Electronic Lock Permits and Submittal Documents for any door requiring City of Houston door lock permit to the HAS IT Project Manager prior to Acceptance Testing.

3.13 CONNECTIONS

1. Ports

A. Identification

1. Each port has been assigned an identifier; combined with the equipment identifier, the sequence becomes unique. Therefore port identifiers may be replicated on separate pieces of equipment because again, the true and complete port ID is coupled to the equipment ID.
2. Example:
 - a. 100.20.01.02.35-39 (equipment ID) + FP03 = 100.20.01.02.35-39 FP03
 - b. 100.25.01.01.12-17 (equipment ID) + FP03 = 100.25.01.01.12-17 FP03
3. Fiber port 03 is replicated on two different pieces of equipment. Coupling it to the equipment ID makes the string unique
4. All ports are identified through a numerical range specific to its respective equipment. Ports may be prefixed with 'FP' (fiber port) or 'CP' (copper port) as is pertinent to the cable category and space allows on the equipment.
5. Regarding service outlets: ports are identified via reference to IDF and IDF equipment (see Outlet). This data should be recorded in the Excel data record tables.
6. Regarding termination panels: ports are identified according to equipment port capacity.
7. Regarding patch panels: ports are identified in sequence and may be prefixed with structure identifier references.
8. Regarding switches: ports are identified in sequence and may be prefixed according to cable compatibility; i.e. 'FP' or 'CP'. The port sequence should follow left-to-right and top-to-bottom.
9. Regarding devices housing multiple blades: ports are identified in sequence as related to respective blades and may be prefixed according to cable compatibility; i.e. 'FP' or 'CP'. The port sequence should follow left-to-right and top-to-bottom.
10. Regarding SYSTIMAX (iPatch) 'equipment panels': ports are identified with a source-over-destination, (panel-to-panel) schema and inclusive of rack/cabinet (structure-unit) identifiers.
11. Regarding SYSTIMAX (iPatch) 'service panels': ports are identified in sequence and may be prefixed with structure identifier references.



B. Labeling

1. All port identifiers follow some specific schema; new ports must be identified accordingly. In the event that a determination cannot be made regarding the identity of the port, please contact the iPatch database administrator prior to documenting.
2. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor

is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.



3. Regarding switches: generally space does not allow for switch port labeling; ports must be identified however in order to correlate circuit connectivity to/from/through the device.
4. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
 - a. DYMO rhinoPRO 5000 Industrial Label Maker
 - b. 3/4" Flexible Industrial Strength Nylon label tape - yellow
5. Labels should be affixed to applicable port locations. Not all ports allow for label placement but these ports should be identified and recorded as part of iPatch SOP; respective to cable or equipment.

C. Required Fields

1. Each port requires that its relationship be established between cable and equipment via use of the iPatch cut sheet (see Exhibits – iPatch SOP.pdf).

D. GPS

1. No action required

E. Supporting Documentation Deliverables

1. ISP cabling/port configurations (see Exhibits – iPatch SOP.pdf)

F. Spatial Data Deliverables

1. No action required

G. Special Instructions

1. Careful attention should be given to accurately accounting for and recording relationships established between ports – cable, and ports – equipment.

3.14 STANDARD OPERATING PROCEDURES – BEST PRACTICES

A. Data Collection Methodology

1. This section includes a general outline of procedures that can be utilized towards the collection and processing of HAS' IT physical data requirements. The outline establishes some of the recommended methods which have proven to be most successful during previous data collection cycles.
2. This guide does not mandate adherence to these methods provided that the contracting party can determine a like process to produce the intended results. Said process must however provide for the specific formatting of all aforementioned physical data deliverables including data record tables, .DWF / .DWG, .PDF, feature class, feature class, and photo imagery.
3. Note: Safety is paramount and discussions with regard to OSHA and other regulatory or governing authorities including Airport Operations must be coordinated with the HAS IT representatives prior to commencement of any project scope.

B. Outside Plant

1. Identify outside plant network locations as defined by project scope of work including all structures, pathways, cable and equipment. This requires extensive communication and coordination with HAS airport campus authorities before and during the evolution. Contracting parties will be provided with respective contact information prior to commencement of data collection effort.
2. Coordinate with HAS IT representative to determine existing network identifiers and to specify any new network identifiers that must be incorporated into data deliverables.
3. If applicable to the GPS equipment that will be utilized to collect data, format custom projections to campus, format code-list.
4. GPS locate structures; ensure all attribute fields are populated. For MH, HH produce field sketch - butterfly layout depicting pathways unit counts orientation; cable types / counts, location. These field sketches should be used to create AutoCAD .DWF / .DWG deliverables.
5. Produce photo imagery
6. GPS locate all splice enclosures, slack loops.
7. Label all end-equipment, splice enclosures, slack loops, cable, pullboxes, cabinets, pedestals. Stamp all MH, HH per guidelines.
8. GPS locate pathways; ensure all attribute fields are populated.
9. Physically locate outside plant associated equipment; ensure all attribute fields are populated.
10. Building Access Points can be approximated where the PATHWAY intersects the building face for purposes of GPS data collection; single-shot.
11. GPS locate cable routing; ensure all attribute fields are populated including end-equipment identifiers.
12. QA/ QC to ensure that all data relationships have been established; i.e. equipment-structure, structure-pathways, pathways-cable and that all attribute fields have been populated.
13. Finalize, format deliverables

C. Inside Plant

1. Identify inside plant network locations as defined by project scope of work including all structures, cable and equipment. This requires extensive communication and coordination with HAS airport campus authorities before and during the evolution. Contracting parties will be provided with respective contact information prior to commencement of data collection effort.
2. Coordinate with iPatch database administrator to determine existing network identifiers and to specify any new network identifiers that must be incorporated into data deliverables.
3. Prepare field sketch (floorplan, rackface) of interior space and equipment. Document and dimension structure space and contents required to generate layouts for the floorplan, cable ladder, conduit, room details, and Install details. Rackface layouts should be created in a separate document. These field sketches should be used to create AutoCAD .DWF / .DWG deliverables.
4. Label all structure units, cable and equipment per guidelines.
5. Record information specific to iPatch SOP for structure units, equipment, cable; this process will be covered in depth at the coordination meeting held prior to commencement of data collection effort. This information establishes infrastructure relationships that will be used to model the communications environment.
6. Test Cable.
7. QA/ QC to ensure that all data relationships have been established; i.e. structure – structure, structure – structure units, structure units – equipment, equipment – ports, ports – cable.
8. Finalize, format deliverables.

END OF SECTION 27 0553

SECTION 271045
RESTROOM MONITORING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 1. Refer to <https://www.fly2houston.com/biz/resources/building-standards-and-permits> for a complete list of related specification sections.
- B. Reference Symbols:
 - 1. All device symbols are defined by the appropriate symbol schedule on the symbols and abbreviations sheet in the systems drawing package. Not all device symbols indicated may be required for the project.
 - 2. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location. Contractor shall coordinate exact locations with all drawings and affected trades prior to submittal of shop drawings.
 - a. The installing Contractor shall coordinate exact locations with all security and telecommunications drawings and site plan drawings as well as all affected trades prior to submittal of any shop drawings.

1.2 SUMMARY

- A. An expansion to the existing Restroom Monitoring System (A.K.A. Smart Restroom) shall be installed at each public restroom space planned in the project). The system shall be a reconfiguration and update of the existing “Smart Restroom” system manufactured by the existing vendor, TRAX.
- B. The Smart Restroom System shall:
 - 1. Count number users of at each Restroom using Bluetooth and video analytics, for the purpose of notification of Janitorial staff to inspect, service consumables and clean the spaces at predetermined thresholds of users.
 - a. Provide airport maintenance and management with statistical data on Restroom usage patterns and trends using beacon interfaced to custodial carts.
 - 2. Provide touch-screen passenger experience at each restroom location support interface to system to collect positive and negative input from users.
 - 3. Additionally, the scope of work shall include all necessary modifications, software upgrades and programming as required to seamlessly integrate the Existing HAS IT Smart Restroom platform. The work includes materials, infrastructure, equipment, software updates, and programming as required to provide a fully integrated and operational system as herein specified.
 - 4. The installation, performance, features, functions, software, and programming modifications as specified herein as well as all related specification sections have been designed to offer the maximum system efficiency ease of operation, occupant safety and enhance the MLIT Experience.
- C. The initial deployment of the Smart Restroom System components shall consist of, but not be limited to, the following.
 - 1. Each restroom shall be provisioned with:
 - a. User counting camera system with video analytics.

- b. Custodial frequency tracking
 - c. Passenger experience touch screen
 - d. Network interface and mini-PC
 - 2. Local Area Network (LAN) and beacon integration shall be performed to support the deployment of all Smart Restroom components as described above.

- D. The Smart Restroom System shall be IP-based. The Contractor shall be responsible for all integration with the other trades and HAS IT for network and low voltage cabling, cable terminations, patch panels, media cabinet (TE) and necessary configuration to provide the functionality described within this document. SRR configuration shall be performed in coordination with HAS IT and the Project Management.
 - 1. In addition to SRR equipment procurement, installation, programming and activation, The Contractor shall furnish and install the following tasks as part of the Work:
 - a. System training as specified.
 - b. System warranty as specified.
 - c. System testing and acceptance plans as specified.

- E. The Division 27 integrator shall be responsible for providing all equipment, devices, system components, final cable terminations, programming, commissioning, and testing of all network communications cabling and equipment in accordance with all related Division 27 Specification Sections.

1.3 REFERENCES

- A. Refer to HAS Standards and specific specification sections for requirements.

1.4 SYSTEMS DESCRIPTIONS

- A. Refer to HAS Standards and specific specification sections for requirements.

1.5 SUBMITTALS

- A. Refer to HAS Standards and specific specification sections for additional information.
- B. Qualifications: Demonstrate compliance with requirements for Contractor certifications and trade skill sets.
- C. Submit Technical Implementation Plan-
- D. Submit manufacturer's technical data for each product provided.
- E. Submit technical and operations manuals.
- F. Include spares list to be approved by HAS IT Project Manager for approval.

1.6 QUALITY ASSURANCE

- A. Refer to HAS Standards and specific specification sections for requirements.

1.7 DELIVERY STORAGE AND HANDLING

- A. Refer to HAS Standards and specific specification sections for requirements.

1.8 RECORD DOCUMENTS

- A. Refer to HAS Standards and specific specification sections for requirements.

1.9 OPERATIONS AND MAINTENANCE

- A. Refer to HAS Standards and specific specification sections for requirements.

1.10 SOFTWARE AGREEMENT

- A. Refer to HAS Standards and specific specification sections for requirements.

1.11 EXTRA MATERIAL

- A. Refer to HAS Standards and specific specification sections for requirements.

1.12 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURED PRODUCTS

- A. Refer to HAS Standards and specific specification sections in addition to the following:
 - 1. All products shall be compatible with the latest revision of existing HAS TRAX Smart Restrooms system product as integrated and provided by TRAX no approved equal.

2.2 SYSTEM CONFIGURATION REQUIREMENTS

- A. Program and configure the Smart Restrooms to be a seamless reconfiguration and upgrade extension of the existing TRAX system.
- B. Perform all network-related work including but not limited to:
 - 1. HAS IT network assignments including port assignments and activation requirements.
- C. Coordinate with HAS network provider to provide optimal performance for the Smart restroom system and the HAS network.

2.3 SYSTEM SOFTWARE, HARDWARE, AND LICENCE REQUIREMENTS

- A. System software shall be TRAX Smart Restroom Systems, no approved equal.
- B. Final System Hardware selection by TRAX.
- C. SMART RESTROOM SYSTEM Configuration to be subcontracted through TRAX.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Refer to HAS Standards and specific specification sections for requirements.

3.2 EQUIPMENT PROTECTION

- A. Protect all materials, equipment, devices, or components permanently installed and/or stored on the job site. Protect all materials, equipment, cabling, devices, or components during construction and after installation, provide appropriate protection of all materials, equipment, components and/or devices until time of substantial completion. All materials, equipment, components and/or devices shall be protected during shipment and storage against any physical damage, dirt, moisture, cold, snow or rain:

3.3 WORK PERFORMANCE

- A. Refer to HAS Standards and specific specification sections in addition to the following:
 - 1. Refer to related Specification Sections for additional project coordination requirements. In addition to the requirements defined in this Specification Section, the contractor shall coordinate and meet all requirements addressed in Division 26, Division 27, and Division 28 Specification Sections.
 - 2. The contractor shall adjust and calibrate the system to provide of performance acceptable to HAS.

3.4 EQUIPMENT INSTALLATION

- A. All system equipment installations shall be in accordance with good engineering practices, NEC, local building codes, and all manufacturer's requirements. Cable terminations at all equipment locations shall comply with all state and local electrical codes. All wiring shall test free from all grounds, shorts, stray voltages, and EMI.
- B. Follow manufacturers and integrator's instructions for installing, components and adjusting all equipment and cabling.

3.5 INSTALLATION REQUIREMENTS

- A. In addition to all demonstration and training as specified by Division 01, HAS Standards and specific specification sections and related Division 27 Specification Sections, system installation shall be provided in accordance with all requirements of this Section.
- B. General
 - 1. SRR installation shall be configured, programmed, and commissioned by TRAX certified programmer.
- C. Software Installation
 - 1. The Contractor shall provide, configure, and program all SRR software in compliance HAS IT approved and existing SRR system offer by TRAX.
- D. Hardware Installation
 - 1. The Contractor shall provide, configure, and install all SRR hardware in compliance HAS IT approved and existing SRR system offer by TRAX.
- E. System Startup
 - 1. The Contractor shall not apply power to the system until after:
 - a. TRAX representative has inspected and approved the SRR configuration and installation for compliance with HAS IT and integrator's system operational requirements.

3.6 COMMUNICATIONS CABLING REQUIREMENTS

- A. Refer to HAS Standards and specific specification sections for requirements.

3.7 ELECTRICAL POWER DISTRIBUTION

- A. Refer to HAS Standards and specific specification sections for requirements.

3.8 TRANSIENT VOLTAGE SUPPRESSION

- A. Refer to HAS Standards and specific specification sections for requirements.

3.9 GROUNDING AND BONDING

- A. Refer to HAS Standards and specific specification sections for requirements.

3.10 EQUIPMENT IDENTIFICATION

- A. Refer to HAS Standards and specific specification sections for requirements.

3.11 MAINTENANCE AND SERVICE

- A. Refer to HAS Standards and specific specification sections for requirements.

3.12 WARRANTY

- A. Refer to HAS Standards and specific specification sections for requirements.

3.13 FIELD SERVICES

- A. Refer to HAS Standards and specific specification sections for requirements.

3.14 TRAINING

- A. Refer to HAS Standards and specific specification sections for requirements.

3.15 PROJECT CLOSEOUT REQUIREMENTS

- A. Refer to HAS Standards and specific specification sections for requirements.

END OF SECTION 27 10 45

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SECTION 271500
HORIZONTAL MEDIA INFRASTRUCTURE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a Structured Cabling System (SCS) for the purpose of supporting voice, data and video communications at various locations within the Houston Airport System. The Houston Airport System (HAS) has established Systemax as the standard for cabling infrastructure installations.
- B. Related Work:
 - 1. Section 27 05 53: Identification and Labeling of Communication Infrastructure
 - 2. Section 27 11 00: Communication Cabinets and Equipment Rooms
 - 3. Section 27 13 00: Backbone/Riser Media Infrastructure
 - 4. Section 27 05 43: Exterior Communication Pathways
 - 5. Section 27 05 26: Telecommunications Grounding and Bonding

1.2 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.05A below.
- B. Manufacturers' data, including part numbers, cut sheets and detailed descriptions, for all proposed equipment.
- C. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Reference Specification 270553 for the Inside and Outside plant spread sheets. Information shall be provided on a CD.
- D. Shop Drawings to be submitted and approved before implementation is started. Shop Drawings to be submitted in accordance with Specification 01340.
- E. Record Drawings: Furnish CAD drawings, following format in Section 01340, of completed work including cable numbers. Refer to Specification 270553 for labeling conventions. Contractor's on-site Building Industry Consulting Services International (BICSI) Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.
- F. Include spares list to be approved by HAS IT Project Manager for approval.
- G. Cable Testing and Reports.
 - 1. Submit Testing Plan prior to beginning cable testing.
 - 2. Submit certified test reports of Contractor-performed tests in accordance with paragraph 3.04. of this document.
 - 3. Electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable identification. Test results must be in both PDF and original raw format of approved tester.
 - 4. Test reports shall be reviewed, approved and with a stamped cover letter by the Contractor's on-site RCDD.
- H. Product data for all termination and test equipment to be used by Contractor to perform work.
 - 1. Equipment shall be calibrated with traceability to National Institute of Standards and Technology (NIST) requirements.
 - 2. Contractor shall include copy of calibration and certification that equipment calibration meets NIST

standards and has been calibrated at least once in the previous calendar year.

3. Test equipment data shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.
4. Refer to 3.04. in this document for test equipment requirements.

I. Submit Technology Implementation Plan in accordance with 1.07 below.

J. Submit Cable Pulling Plan, as follows:

1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
2. Indicate contents of each conduit.
3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
4. Cable Pulling Plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submittal.
5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the Architect/Engineer.

K. Submit installation plan indicating:

1. Equipment and personnel
2. Materials and staging area
3. Start and completion dates
4. Locations, including floor, room and building
5. Installation plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.

1.3 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

C. Maintain temperature of between 64 degrees Fahrenheit and 75 degrees Fahrenheit and between 30 and 55 percent humidity in areas of active electronic system work.

1.4 REFERENCES

A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect two weeks prior to the date of the Bidding Documents unless the document is shown dated.

C. Conflicts.

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.

D. References.

1. ANSI/TIA/EIA-568-D, Commercial Building Telecommunications Wiring Standards

2. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
3. ANSI/TIA/EIA 607-B -Commercial Building Grounding and Bonding Requirements
4. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS11801, January 6, 1994
5. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program
6. National Electrical Manufacturers Association (NEMA)
7. American Society for Testing Materials (ASTM)
8. National Electric Code (NEC®) Latest Issue
9. National Electrical Safety Code (NESC) Latest Issue
10. Institute of Electrical and Electronic Engineers (IEEE)
11. UL Testing Bulletin
12. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps
13. SYSTIMAX Structured Cabling Systems, Performance Specifications, Latest Issue
14. SYSTIMAX Structured Cabling Systems, Components Guide, Latest Issue
15. BICSI Telecommunications Distribution Methods Manual (TDMM) Latest Issue
16. Rural Utilities Service (RUS) Section 1755

1.5 QUALITY ASSURANCE

- A. Submit written proof that the following experience requirements are being met.
1. Contractor Qualifications
 - a. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
 - b. Must be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC methods, standards and codes.
 - c. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses.
 - d. The contractor shall provide five references for projects of equivalent scope, type and complexity of work completed within the last five years.
 - e. The contractor who is installing the cabling infrastructure shall be a certified and currently registered Commscope/Systimax Premier Partner capable of issuing a numbered registration certificate for the entire cable system.
 - f. The contractor who is installing the cabling infrastructure shall have the following Systimax iPatch/imVision certifications:
 - 1) SP/ND3360 - SYSTIMAX SCS 360 Solutions
 - 2) SP/ND3321 - SYSTIMAX SCS Design & Engineering
 - 3) SP/ND3361 - SYSTIMAX SCS Installation and Maintenance
 - 4) GL5555 - SYSTIMAX SCS Certified imVision Support Specialist
 - 5) SP/ND5500 - SYSTIMAX SCS iPATCH Design & Engineering
 - 6) SP/ND5510 - SYSTIMAX SCS Certified iPATCH Support Specialist (CISS)
 - g. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.
 2. Manufacturer's hardware experience: All components shall be produced by manufacturers who have been regularly engaged in the production of telecommunications cabling components of the types to be installed in this project for a period of five years.
- B. Materials and equipment: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. The equipment shall meet the following requirements:
1. Interior controlled environment: 60 to 100 degrees F dry bulb and 20 to 90 percent relative humidity, non-condensing.
 2. Interior uncontrolled environment: 0 to 130 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing.

3. Exterior environments: Minus 30 degrees to 130 degrees F dry bulb, and 10 to 100 percent relative humidity, condensing.
4. Hazardous environment: All system components located in areas where fire or explosion hazards may exist because of flammable gas or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings, shall be rated and installed according to Chapter 5 of the NFPA 70 and as shown.

C. Standard products:

1. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.
2. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

1.6 CONTRACTOR'S DUTIES

- A. Contractor's RCDD shall provide all calculations and analysis to support design and engineering decisions as specified in the Submittals section.
- B. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services/programming to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.
- C. Secure and pay for plan check fees, permits, fees, and licenses necessary for the execution of Work as applicable for the project.
- D. Give required notices.
- E. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.7 PROCUREMENT

- A. Procure equipment specified in this document as dictated by the timeline in Appendix A "Technology Implementation Schedule" in order to ensure that the technology is acquired in a timely fashion, but not outdated by the installation date.
- B. Submit a copy of Appendix A "Technology Implementation Schedule" as a part of the equipment submittals required elsewhere in this document. Complete the columns headed "Quantity", "Purchasing Lead Time", "Start Date or Dependent", and "Installation Duration".
- C. The "Procurement Lead Time" shall be expressed in days or weeks, and shall include time required for the contractor's personnel to order and receive the material. Substantiation may be required.
- D. "Start Date or Dependent" and "Installation Duration" should be an accurate estimate based upon known facts in the project. Substantiation may be required.
- E. The Contractor shall not purchase any materials requiring submittals until the owner approves the product submittal and the Technology Implementation Schedule for that material.
- F. The Contractor shall not purchase any materials requiring submittals until the date established by the owner as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the "Purch Auth" column of Appendix A as a part of the Submittal Review process.

1.8 MAINTENANCE AND SUPPORT

- A. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568 or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty-year period.
- B. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.
- C. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty period.

1.9 EXTENDED WARRANTY

- A. The Extended Product Warranty shall meet all manufactures specification to ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568 and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of ANSI/TIA/EIA 568 and ISO/IEC IS 11801 for cabling links/channels, that the installation will exceed the loss and bandwidth requirements of ANSI/TIA/EIA 568 and ISO/IEC IS 11801 for fiber links/channels, for a twenty year period. The warranty shall apply to all passive SCS components.
- B. The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products.

1.10 DELIVERY AND STORAGE

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the City.

1.11 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to SYSTIMAX SCS and other manufacturers as referenced in this document. However, substitutions for Systimax products are not permitted.

2.2 GENERAL

- A. Provide all cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in the Main Distribution Facility (MDF) and the Intermediate Distribution Facilities (IDFs).

2.3 COPPER CABLE GENERAL REQUIREMENTS

- A. Manufacturer Qualifications: ISO 9001 Certified and included in the Underwriters Laboratories LAN Certification and Follow-up Program.

2.4 COPPER HORIZONTAL CABLING

- A. Manufacturer: SYSTIMAX SCS XL7– XX71.
- B. All horizontal cabling shall meet or exceed the ANSI/EIA/TIA-568 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components.
- C. Cables shall be marked as UL verified with a minimum of Category 6 rating.
- D. All horizontal cabling shall be color-coded as follows to differentiate between tenant and owner cabling. All voice circuits will be terminated on patch panels. All horizontal cabling will terminate on patch panels. All tenant and specialty circuits will be cross connected to multi-pair cabling as required.
 1. Green – HAS Data. (This applies to all HAS devices needing data cabling)
 - a. IP Cameras
 - b. Wireless Access Points(APs) – (Requires two CAT 6A data cables for 802.11ACv2)
 - c. Access Control Panels
 - d. IP Phones
 - e. Etc
 2. Yellow – Tenant Data
 3. Red – Special circuits, including Automated External Defibrillation (AED) Circuits
 4. Blue – CBP (Cat 6A)
 5. Purple – TSA (Cat 6A)
 6. White – CBP Access Control Video Systems (Cat 6A)
- E. High performance (71 Series) Category 6 UTP, 4 Pair cabling shall be utilized to provide the signal medium from the individual workstation location to the IDF(s) unless denoted otherwise on the drawings. This cabling shall be installed in accordance with the contract drawings and shall adhere to the specifications listed below:
 1. 4 pair UTP
 2. 23 AWG Solid Bare Copper
 3. Cable jacket shall comply with NEC Article 800 for use as a plenum cable and shall be UL and c (UL) Listed Type CMP.
 4. Cable shall terminate on 8 pin modular jack at each outlet.

- F. The high performance Category 6 UTP cable shall be of the traditional round design with mylar separator tape between pairs 2/3 and 1/4. The cable shall support Voice, Analog Baseband Video/Audio, Fax, Modem, Switched-56, T-1, ISDN, RS-232, RS-422, RS-485, 10BASE-T Ethernet, Token Ring, 100Mbps TP-PMD, 100BASE-T Ethernet, 155 Mbps ATM, AES/EBU Digital Audio, 270 Mbps Digital Video, 622 Mbps 64-CAP ATM and emerging high-bandwidth applications, including 1 Gbps Ethernet, gigabit ATM, as well as all 77 channels (550 Mhz , single swept margin) of analog broadband video.
- G. The high performance Category 6 cables shall meet or exceed the electrical characteristics set by the manufactures specifications.
- H. The high performance Category 6 cable shall be specified to 550 MHz and shall meet the guaranteed swept margin as set by the manufacture.

I. Systimax part numbers for Plenum-rated Horizontal Cabling are as follows:

| Product Number | Color | COM code | Qty per Unit |
|----------------|--------|-----------|--------------|
| 2071E YEL C6 4 | Yellow | 700210123 | W1000 |
| 2071E SGR C6 4 | Green | 700210164 | W1000 |
| 2071E RED C6 4 | Red | 700210263 | W1000 |
| | | | |
| | | | |

2.5 UNITED AIRLINES COPPER HORIZONTAL CABLING

- A. Category 6 UTP Plenum Rated Cable.
 - 1. Belden RevConnect 2400 Series - Blue
- B. Category 6A UTP Plenum Rated Cable.
 - 1. Belden RevConnect 10GXW Series Plenum Rated – Orange

2.6 VIDEO COAXIAL CABLE (MATV)

- A. Manufacturer: CommScope or approved equivalent.
- B. The shielded, plenum RG-11 cable shall be used where the horizontal run is greater then 350 feet or specified in the Contract Drawings.
 - 1. Shall consist of a 14-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
 - 2. CommScope part number – 2287K WHRL RG11 QD 1000 4103304/10
 - 3. Must use compression type connectors from IDEAL part number:
 - 4. IDEAL F connector - #89-011
 - 5. The copper cable shall meet or exceed the electrical specifications set by the manufacture.
- C. The Quad shielded, plenum RG-6 cable shall be used as horizontal where specified in the Contract Drawings.
 - 1. Shall consist of a 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
 - 2. CommScope part number – 2227V WHRL RG6 QD 1000 4112704/10
 - 3. Must use compression type connectors from IDEAL part number:
 - a. IDEAL F connector - RG6-F-XR-RTQ #92-651
 - b. IDEAL BNC connector - RG6-INSITE-BNC #89-048(security camera install only)
 - 4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.

2.7 SECURITY CABLES

- A. Manufacturer: CommScope or approved equivalent.
- B. RG-6(for analog cameras) cable shall be used as horizontal where specified in the Contract Drawings. This cable supplies both video and power media.
 - 1. Shall consist of an 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
 - 2. CommScope part number – 5654
 - 3. Must use compression type connectors from IDEAL part number:
 - a. IDEAL F connector - RG6-F-XR-RTQ #92-651
 - b. IDEAL BNC connector - RG6-INSITE-BNC #89-048(security camera install only)
 - 4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.
- C. RG-6(for analog cameras) cable shall be used as horizontal OUTDOOR use where specified in the Contract Drawings.
 - 1. Shall consist of an 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
 - 2. CommScope part number – 5720
 - 3. Must use compression type connectors from IDEAL part number:
 - a. IDEAL F connector - RG6-F-XR-RTQ #92-651
 - b. IDEAL BNC connector - RG6-INSITE-BNC #89-048(security camera install only)
 - 4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.
- D. Composite Cables: Cable between controlled portals and IFPs shall consist of multiple conductor bundles affixed together via a central spline. The conductor bundles shall consist of the following:
 - 1. 4C, 18 AWG 16/30 STR, shielded
 - 2. 3P, 22 AWG 7/30 STR, shielded
 - 3. 2C, 22A AWG 7/30 STR, shielded
 - 4. 4C, 22 AWG 7/30 STR, shielded
 - 5. The composite access control cable shall be Honey Well Genesis 3295 or approved equivalent.
- E. 4 CONDUCTOR CABLE (for use with dry contact devices including door position switches, duress alarm switches, etc).
 - 1. 4 stranded (7 x28) tinned copper conductors
 - 2. Nominal O.D.: .217”
 - 3. Belden 9444 or approved equivalent

2.8 FIBER PATCH CORDS

- A. Manufacturer: SYSTIMAX Solutions ONLY. If required see specification 271300.

2.9 COPPER HARDWARE TERMINATION STANDARDS - Real Time Infrastructure Management - Intelligent Patch Panel System

- A. All horizontal data cables to terminate on iPatch panel. If a rack manager does not exist in the cabinet one must be added to manage the horizontal infrastructure.
- B. Systimax Solution iPatch Intelligent Fiber Optic Patching System as follows:

| Product Number | Description |
|--|--|
| Fiber Shelves (19 inch rack-mountable) and accessories | |
| 760209940 | HD-1U - 1U sliding fiber shelf(holds four modules) |
| 760148502 | 360-LP-STACK-SPT |
| | |
| 760109470 | 12-LC-LS-AQ-Pigtails |
| | |
| 760109496 | 12-LC-SM-BL-Pigtails |
| 760109504 | 12-LCA-SM-GR-Pigtails |
| | |
| | |
| Copper Patch Panels - Cat 6 | |
| 760201137 | 360-iP-1100-E-GS3-1U-24 - 360 iPatch/imVision(enabled) 24 port panel |
| 760201111 | 360-iP-1100-E-GS3-2U-48 - 360 iPatch/imVision(enabled) 48 port panel |
| 760152561 | 360-IPR-1100-E-GS3-1U-24 - 360 iPatch/imVision(ready) 24 port panel |
| 760152579 | 360-IPR-1100-E-GS3-2U-48 - 360 iPatch/imVision(ready) 48 port panel |
| | |
| Copper Patch Panels - Cat 6A | |
| 760201145 | 360-iP-1100-E-GS6-1U-24 - 360 iPatch/imVision(enabled) 24 port panel |
| 760201129 | 360-iP-1100-E-GS6-2U-48 - 360 iPatch/imVision(enabled) 48 port panel |
| | |
| imVision Rack manager | |
| 760161380 | 360-imV-CNTRLR - 360 imVision Panel Manager (1 per rack / cabinet) |
| | |

C. Modular Patch Cords

1. Manufacturer: Systemax SCS-GS8E
2. Provide Category 6, Modular Patch Cords for each installed port designated as “Data” in the Drawings.
3. All cords shall conform to the requirements of ANSI/TIA/EIA 568 Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL® LAN Certification and Follow-up Program. Cords shall be equipped with an 8 pin modular connector on each end and shall conform to the length(s) specified on the detailed drawing. All Category 6 cordage shall be round, and consist of 23-AWG copper, stranded conductors, tightly twisted into individual pairs and shall meet or exceed the electrical specifications set by the manufacture.

4. UTP Patch cord lengths will be deployed as follows:

| Length | Location/Application |
|--------|--|
| 3 ft | MDF, IDF, Computer Room, and Lab |
| 5 ft | MDF, IDF, Computer Room, and Lab |
| 7 ft | MDF, IDF, Computer Room, and Lab |
| 9 ft | MDF, IDF, Computer Room, Office, Cubicle, or Lab |
| 15 ft | Office, Cubicle, or Lab |

5. Copper patch cord part numbers are as follows:

| Product Number | Length | Material ID |
|----------------|--------|----------------|
| GS8E-3ft | 3FT | CPC3312-03F003 |
| GS8E-5ft | 5FT | CPC3312-03F005 |
| GS8E-7ft | 7FT | CPC3312-03F007 |
| GS8E-9ft | 9FT | CPC3312-03F009 |
| GS8E-15ft | 15FT | CPC3312-03F015 |

NOTE: 15 ft. UTP patch cords shall be used at the workstation only.

D. Hybrid RJ45 to 110 Patch Cords.

1. Manufacturer: Systimax 119P2PS
2. As required provide Category 6, Hybrid Patch Cords for each assigned data/voice port on the patch panel. Cords shall RJ45 connector on one end and 110GS on the other end. Cords shall be provided in appropriate lengths to accommodate all tenant voice or specialty ports as shown in detailed drawings. All Category 6 cordage shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pair and shall meet or exceed the Category 5e specifications.
3. Hybrid patch cords shall conform to the TIA 568B wiring scheme.
4. Hybrid patch cords shall be provided for each installed port designated as “Tenant Voice or Specialty jack” in the drawings.
5. Hybrid patch cord single pair part numbers are as follows(last 3 digits designates length):

| Length | Material ID |
|--------|-----------------|
| 8FT | CPC8662-03F-008 |
| 10FT | CPC8662-03F-010 |

| | |
|--|--|
| | |
| | |
| | |

6. Hybrid patch cord 4 pair part numbers are as follows(last 3 digits designates length):

| Length | Material ID |
|--------|-----------------|
| 8FT | CPC8312-03F-008 |
| 10FT | CPC8312-03F-010 |

E. Outlets

1. Manufacturer: Systimax
2. Systimax MGS400 Modular GigaSpeed Information Outlets - 8 position/8 conductor non-keyed modular outlets for applications up 1 Gbps and ANSI/TIA/EIA 568 compliant for Category 6 transmission requirements and be part of the UL® LAN Certification and Follow-up Program.
3. Outlets shall meet or exceed the following electrical and mechanical specifications set by the manufacture.
4. Standard installations shall utilize orange outlets for data. Dust Cover/Blanks shall match faceplate cover.
5. All IMO's (Interactive Media Outlet) shall have at a minimum 4-data ports at each location unless otherwise specified by the contract documents.
6. Systimax MGS400 Modular GigaSpeed Information Outlets part numbers are as follows:

| Product Numbering | # per pack | Color | COM code |
|-------------------|------------|--------|-------------|
| MGS400-112 | 1 | Orange | 700 206 683 |

7. Systimax M-Series Modular Faceplates designed for use with M-Series Modular Information Outlets:

| Product Numbering | # of ports | # per pack | Color | COM code |
|-------------------|------------|------------|-------|-------------|
| M10L-262 | 1 | 1 | White | 108 258 427 |
| M10LW-262 | 1 (wall) | 1 | White | 108 258 468 |
| M12L-262 | 2 | 1 | White | 108 168 469 |
| M14L-262 | 4 | 1 | White | 108 168 543 |

8. Systimax M-Series Modular Surface Mount Box designed for use with one to four M-Series Modular Information Outlets. May be mounted on a flat surface with screws, Box color shall match wall/furniture surface color:

| Product Numbering | # of ports | # per pack | Color | COM code |
|-------------------|------------|------------|-------|-------------|
| M104SMB-262 | 4 | 1 | White | 107 952 459 |
| M104SMB-270 | 4 | 1 | Gray | 107 952 467 |

2.10 UNITED AIRLINES OUTLETS

- A. Category 6 modular keystone jacks
 - 1. Hubbel

2.11 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. Any deviation from the specification must be approved by HAS IT prior to installation.

2.12 CABLE MANAGEMENT

- A. Horizontal Manager
 - 1. Manufacturer: CPI – 30130-719
- B. Fiber patch cords
 - 2. Manufacturer: Panduit – Fiber runner(Applies to all new or expand existing BDF/MDF/Computer room build outs)

2.13 SPECIAL APPLICATIONS SHIELDED TWISTED PAIR SOLUTION

- A. Shielded Cable
 - 1. CommScope Shielded Cable, F/UTP Plenum Rated Category 6A, Black Jacket, 1000ft Length

| Product Numbering | # per pack | Color | COM code |
|----------------------|------------|-------|-----------|
| 2291B BK 4/23 R1000 | 1000ft | Black | 760171025 |
| 2291B GRN 4/23 R1000 | | Green | 760122663 |

- B. Shielded Outlets
 - 1. CommScope Shielded Outlet, Category 6A, F/UTP

| Product Numbering | # per pack | Color | COM code |
|-------------------|------------|----------------|-----------|
| HGS620 | 1 | Silver (F/UTP) | 760152801 |

* If the HGS620 information outlet is to be used at WAO, the depth of any backboxes must be increased.

C. Shielded Patch Panels

1. CommScope Shielded Panel, 1U, 24 Port, F/UTP Flat. imVision / iPatch system preinstalled, ships with 24 shielded outlets

| Product Numbering | # per pack | Color | COM code |
|--------------------------|------------|--------|-----------|
| 360-iP-MFTP-E-HD6B-1U-24 | 1 | Silver | 760201178 |

D. High Density M-Series Adapter

1. Systimax High Density M-Series Adapter - White

| Product Numbering | # per pack | Color | COM code |
|-------------------|------------|-------|-----------|
| HGS-A-MS-WHITE | 1 | White | 760154187 |

E. Shielded Patch Cords

1. CommScope Shielded Patch Cords, F/UTP, Black Jacket, RJ45-RJ45, 7ft

| Product Numbering | # per pack | Color | COM code |
|-------------------------|------------|-------|----------------|
| PCOSP-6AS-BK-07FT (OSP) | 1 | Black | CO11192-01F007 |
| G10FP-GR-7FT | | Green | CPCZZK1-01F007 |

2.14 BATHROOM STALL OCCUPANCY SENSOR LIGHT CABLE

- A. Plenum-CL2P, 2 Conductor 14 AWG stranded bare copper wire.
 1. Belden 6100UE.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify raceways, boxes, hand holes and maintenance holes are properly installed following Sections 270528, and 270543.
- B. All communication media must be installed in conduit or cable tray unless an alternate method has been approved by HAS/IT.
- C. Verify horizontal conduit is minimum 1-inch diameter.
- D. Verify backboards are properly installed.
- E. Verify telecommunications grounding system is properly installed and tested following Section 270526.

- F. Verify liquid-carrying pipes are not installed in or above any IDF/MDF that has active electronic equipment. Do not proceed with installation in affected areas until removed.

3.2 PREPARATION

- A. Environmental controlled communication rooms shall maintain temperature of between 64 degrees Fahrenheit and 78 degrees F and between 30 and 55 percent humidity in areas of active electronic system work.
- B. Cable Splicing: Exact cable routing, splice enclosure locations, distances, elevations, work space and purpose of splice will be governed by actual field conditions. Contractor shall perform field surveys prior to submitting layout drawings.
- C. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

3.3 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data are included on the drawings.
- B. All installation shall be done in conformance with ANSI/TIA/EIA 568 standards, BICSI methods, Industry standards and SYSTIMAX SCS installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- C. The SCS installation shall comply with all applicable national and local codes pertaining to low voltage cable system installations.
- D. The contractor shall adhere to the installation schedule of the general contractor and shall attend all construction meetings scheduled by the general contractor.
- E. Upon structural completion of the communications room(s) and prior to the installation of any communications equipment or supporting devices inside the room, the HAS IT Representative shall consult the Communications Designer in order to:
 - 1. Perform construction administration activities to compare as-built configuration to the design.
 - 2. Observe all "not-to-design" compliance issues and issue corrective advisement of actions.
 - 3. Upon completion of 1 and 2 above, the Communications Designer shall mark with masking tape the general layout of the equipment placement.
- F. All communications conduits shall be identified with color coded orange tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-box locations) with the origination, destination and device name (if applicable) location.
- G. Vertical Cabinet Installation
 - 1. All Cabinets shall be properly positioned, leveled, ganged, anchored, grounded and powered.
 - 2. All Cabinets shall be populated as noted in drawings with termination hardware, equipment, proper patch cord lengths, and power outlets.
 - 3. Install and anchor all vertical equipment cabinets to floor following the Drawings and manufacturer's instructions.
 - 4. All cabinets shall be properly ganged in each bay as shown in the Drawings.
 - 5. All cabinet doors shall be configured as shown in the Drawings.

6. All cabinets shall be properly labeled per specification 270553.
 7. After final acceptance of the cabinets, coordinate with Owner to replace key/lock with silver barrel on front and back doors.
- H. The contractor shall perform all required cross connections of the horizontal cable runs to the backbone cable system. The equipment connections to the data systems shall be performed by the vendors installing and/or maintaining those systems.
- I. The contractor is responsible for providing a CD with all the cable/patch panel information in the same format that will be accepted for download in HAS's iPatch/imVision database 1 month before any patching is completed.
- J. The contractor is responsible and must perform the following task associated with the iPatch system:
1. Connect iPatch/imVision Network Manger to designated port on HAS network switch.
 2. Inter-connect iPatch/imVision Network Manager to rack managers if applicable.
 3. Confirm that all iPatch/imVision patch panels are on line.
 4. Configure network settings for iPatch Network Manage with IP address, Mask and Gateway.
 5. Resolve patching conflicts associated with "Confirm" message on the iPatch Network Manager Display.
 6. Resolve conflicts associated with "Alarms" on iPatch/imVision Network Manager.
 7. Provide fiber cut sheet depicting fiber port to port or port to equipment connectivity.
 8. Provide an excel file compatible with iPatch/imVision Bulk Import tool. The file will be used to build rooms, faceplates and jacks in iPatch/imVision database.
 9. Label all new devices including the iPatch/imVision Network Manager according to HAS labeling specs.
 10. Label all components according to HAS labeling specs.
 11. Provide floor plans depicting rooms lay out and outlet locations.
 12. Confirm iPatch/imVision ports are pointing toward the proper end device (iPatch/imVision to equipment or iPatch/imVision to iPatch/imVision connection).
 13. Data cabling contractor is to provide and install an iPatch/imVision 48 port copper patch panel for all new network switches/blades that are related to the project. Provide solid conductor patch cables with RJ-45 on one end and terminate the other end on the patch panel. Patch port 1 of the patch panel to port 1 on the switch until all ports on the switch are connected to the patch panel matching the port numbers.
- K. The contractor shall provide service loops (slack) for cables terminating in the IDFs. A 6-foot service loop shall be provided above the access ceiling or cable trays unless specified otherwise. This allows for future changes or expansion without installing new cables.
- L. The installation contractor shall be responsible for coordination, testing and problem resolution with the system vendors.
- M. City inspector or their designated representative shall randomly perform unannounced, on-site reviews during the installation. In addition, this person shall perform a final inspection and a complete review of the test results before the installation is accepted.
- N. Upon completion of the installation, Contractor shall prepare as-built documentation of the entire SCS. This documentation shall include:
1. As-Built Drawings
 - a. All drawings shall be provided on disk in a form compatible with AutoCAD Version 14. A complete set of project plans will be provided by the Contractor on CD.
 - b. A complete diagram of all terminations in the IDFs.
 - c. A complete diagram of all copper, fiber, and coax riser cable.
 - d. A complete diagram of all copper, fiber, and coax inter-building cable.
 - e. Floor plans showing exact cable routings with each outlet clearly marked with cable number.
 - f. A complete diagram of all cable tray, conduits and conduit sleeves.
 2. Documentation

- a. All cable inventory data documentation shall be submitted in designated as specified in specification 270553
 - b. Documentation on horizontal cable shall include cable number and length of cable.
 - c. Complete cross connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.
3. As-built Drawings and Documentation shall be reviewed, approved and stamped by Contractor's on-site RCDD.

3.4 POST-INSTALLATION TESTING AND CERTIFICATION

A. Contractor Requirements

1. Contractor shall provide sufficient skilled labor to complete testing within a reasonable test period.
2. Contractor shall have a minimum of three years of experience installing and testing structured cabling systems. All installers assigned by the Contractor to the installation shall be certified by the factory to install and test the provided products.
3. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.
4. Contractor is responsible for submitting acceptance documentation as defined in 3.04.D below. No cabling installation is considered complete until test results have been completed, submitted and approved as defined in 3.04.D below.
5. Contractor to insure that the database information for iPatch meets the HAS requirements.

B. Test Procedure

1. HAS IT Representative reserves the right to be present during any or all testing. Notify HAS IT Representative at least 48 hours prior to beginning test procedures.
2. Testing shall be of the Permanent Link. However, Contractor shall warrant performance based on Channel performance and provide patch cords that meet channel performance.
3. All cabling not tested strictly in accordance with these procedures shall be re-tested at no additional cost to the Owner.
4. Testing of all copper and fiber wiring shall be performed prior to system(s) cutover.
5. 100% of the installed cabling shall be tested. All tests shall pass acceptance criteria defined in 3.05 below.
6. Cable testing shall be performed by a fully charged tester, and the charging unit shall be disconnected during testing.
7. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor at no charge to the City. Complete end-to-end test results shall be submitted to the City.

C. Standards Compliance and Test Requirements

1. Copper Cabling shall meet the indicated performance specifications:
 - a. Category 6 Horizontal Cabling shall be tested to the manufactures specification for Category 6 Cabling and SYSTIMAX SCS GigaSpeed System.
2. All test equipment used shall meet the performance specifications defined in 3.04.

D. Cable Test Documentation

1. Test reports shall be submitted in hardcopy and electronic format and certified by the contractor's RCDD to be a complete and accurate record of cabling installed. Hand-written test reports are not acceptable.
2. Hardcopy reports are to be submitted in labeled three-ring binders with an attached affidavit verifying passing execution of all tests. Hardcopy summary reports shall contain the following information on each row of the report: circuit ID, test specification used, cable length, date of test, and pass/fail result.
3. Electronic reports shall be submitted on CD in PDF format. Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and ac

curacy of the electronic report. Certificate shall reference traceable circuit numbers that match the electronic record.

4. Hardcopy and electronic reports for each cable route shall be submitted together in one submittal. The submittal description shall include the type of test performed, type of cable, and cable ID (including originating and terminating room numbers) of cable tested. Partial or unclear documentation will be returned without reviewing.
5. Test reports shall include the following information for each cabling element tested:
 - a. Wiremap results that indicate that 100% of the cabling has been tested for shorts, opens, miswires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
 - b. For Category 6 cabling: Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards. Any individual test that fails the relevant performance specification shall be marked as a FAIL. Test shall also include mutual capacitance and characteristic impedance.
 - c. Length (in feet), propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
 - d. Cable manufacturer, cable model number/type, and NVP
 - e. Tester manufacturer, model, serial number, hardware version, and software version
 - f. Circuit ID number and project name
 - g. Autotest specification used
 - h. Overall pass/fail indication
 - i. Date of test
6. Test reports shall be submitted within seven business days of testing.

E. Test Equipment

1. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years of experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.
 - a. Category 6 – At minimum a Level III tester or submitted and owner-approved equivalent.
 - b. Refer to spec section 27 13 00 for fiber testing procedures.
2. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.
3. Test adapter cables shall be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable.
4. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.
5. Test equipment shall be capable of certifying Category 6 links.
6. Test equipment shall have a dynamic range of at least 100 dB to minimize measurement uncertainty.
7. Test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
8. Test equipment shall include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
9. Test equipment shall be capable of running individual NEXT, return loss, etc measurements in addition to autotests. Individual tests increase productivity when diagnosing faults.
10. Test equipment shall include a library of cable types, sorted by major manufacturer.
11. Test equipment shall store at least 250 Category 6 autotests (in full graphic format) in internal memory, with the option for additional storage card via expansion slot.
12. Test equipment shall be able to internally group autotests and cables in project folders for good records management.
13. Test equipment shall include DSP technology for support of advanced measurements.
14. Test equipment shall make swept frequency measurements in compliance with TIA standards.
15. The measurement reference plane of the test equipment shall start immediately at the output of the test

equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.

3.5 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and HAS IT Representative is satisfied that all work is in accordance with contract documents, the HAS IT Representative will notify Contractor in writing of formal acceptance of the system.
- B. Acceptance Requirements
 1. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified under 3.04. "Standards Compliance & Test Requirements" above.
 2. HAS IT Representative reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent of the cable plant to confirm documented results. Random re-testing, if performed, shall be at the expense of the City, using standard labor rates. Any failing cabling shall be re-tested and restored to a passing condition at no cost to the City. In the event more than two percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.
 3. HAS IT Representative may agree to allow certain cabling runs to exceed standardized performance criteria (e.g. length). In this event, such runs shall be explicitly identified and excluded from requirements to pass standardized tests.
 4. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and submittal and approval of full documentation as described in 3.04.
 5. See Appendix A & B. Acceptance requirements are not limited to these sheets

3.6 DEMOLITION

- A. The contractor shall be responsible for maintaining all communications service to areas of the building scheduled to remain in service during the period of renovation.
- B. Notify HAS Information Technology (IT) department 30 days prior to the start of demolition work taking place in existing communications rooms. Coordinate removal of equipment and cabling within existing communications rooms with HAS IT.
- C. Where removal is indicated in Drawings, remove communications cable from termination point back to originating communications room, MDF or tenant communications room. Coordinate removal at terminating blocks and panels with HAS IT. Coordinate removal of cross-connects and patch cables with HAS IT.
- D. Ensure systems and circuits are no longer active before removing and prior to the demolition of existing communications rooms. If active circuits exist at time of scheduled demolition, coordinate with HAS IT Representative to reroute or deactivate circuit(s).
- E. Demolition and removal of cabling shall not impact the operation of active systems.
- F. Unless otherwise noted, discard all removed cable, patch cables and cross-connects. Except where re-routing of cable is specified in Drawings or by Designer, do not reuse cable.
- G. Remove all loose unterminated cabling to source found above ceiling, under floor or in wall.
- H. Demo all abandoned cable in accordance with NEC 800.25.

3.7 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

END OF SECTION 27 1500

APPENDIX A

MDF/IDF Check List

This list is intended as a minimum checklist. CM should ensure that the contractor's schedule has built in these components and the necessary buffer period – and associated access restrictions to the communications equipment rooms -- for HAS IT and tenant IT to prepare.

1. All communication rooms that will service the area to be opened must be completed. That means a final walkthrough of these areas has been completed. It is not necessary that the entire project achieve substantial completion, but IT cannot install equipment and begin work until the following minimum criteria is met:

- a. Space is built out and clean – free from dust/residues.
- b. Electrical w/UPS as required.
- c. All racks/cabinets installed and mounted. Padlocks eyes have been installed.
- d. Grounding bus bar installed and properly tied to main grounding bus bar in MDF
- e. HVAC functioning properly and is adequately filtering dust. Humidity is controlled.
- f. Door access control is installed (card reader) -or- an approved temporary provision. Simple key access is not permissible.
- g. Lighting is installed and operational.
- h. Cable trays/ladder racks installed and ready to use.
- i. Permanent or temporary signage identifying permanent room number.

2. All cabling necessary to operate the areas to be opened is completed.

- a. Backbone cabling (copper and fiber) from the applicable communication room(s) is installed, tested, labeled, and approved by the inspector and communications design consultant.
- b. Horizontal cabling for all areas to be occupied is installed, tested, labeled, and approved by the inspector and communications design consultant.
- c. Copper cross connects and/or fiber jumpers have been installed per the owner/tenant requirements.
- d. Cable records and redline drawings for installed cables are submitted and approved PRIOR to putting any active circuits on the new cables. Cable records reflect all installed cables **and** any cross connects or jumper assignments installed by the contractor.
- e. All iPatch Panels are programmed and operational.
- f. All jumpers and patch cords specified by the contract are transmitted to the owner for use.
- g. NOTE: cable labels and permanent room numbers need to match. CM needs to be sure to get design team, airport, IT, and CM / contractor reps together to review permanent room numbers prior to contractor installing cable labels.

3. Move-in buffer period needs to be minimum 6 **weeks** for HAS-IT to install/extend services within the area to be occupied prior to occupation of the facility or spaces. Additional time may be necessary if Tenant IT organization is involved, or if contractor has other systems that must be configured/tested which require HAS-IT resources (i.e. cabling or data network connections). This is frequently the case for PA System, television, radio, Fire Alarm, pay telephone, EFSO (Electronic Fuel Shutoff), access control & CCTV, etc.

4. Once HAS-IT accepts a communications equipment room and begins to install/configure equipment in preparation for hosting live applications, this room becomes a restricted area with access to be controlled by HAS-IT. Contractors must be substantially complete with systems inside the communications equipment room so that access is generally not required. Minor punch list and scheduled testing with escort can be arranged, but access will be very limited.

5. Other IT-related systems that must be operational, tested, and accepted or approved temporary provisions.

- a. PA System
- b. MATV and/or CNN TV (where applicable)
- c. Fire Alarm
- d. MUFIDS
- e. Pay Telephones (where applicable)
- f. EFSO (where applicable)
- g. Access Control & CCTV (note: must be PROGRAMMED, and approved acceptance test walk through by HAS)
- h. Crash phone (where applicable)
- i. Radio system enhancements (where applicable)
- j. Data Network switch installed and configured.

APPENDIX B

| | | | | |
|--|---|------------|-----------|-----------------|
| | Fiber strain relief properly applied | | | |
| | Routing | | | |
| | Cables properly supported | | | |
| | Pull tensions properly recorded | | | |
| | Sheath damage | | | |
| | Bend radius observed | | | |
| | Properly dressed in tray | | | |
| | Fiber installed in inner duct | | | |
| | Properly dressed in termination shelf | | | |
| | Any splice cases properly supported | | | |
| | Room Layout: | YES | NO | COMMENTS |
| | Room laid out according to project drawings | | | |
| | Proper clearances maintained | | | |
| | Is the room clean & neat in appearance | | | |
| | Liquid carrying pipes within the room | | | |
| | Pathways: | YES | NO | COMMENTS |
| | Conduit properly routed & supported | | | |
| | Cable Tray properly routed & supported | | | |
| | Inner Duct used to route fiber and properly supported | | | |
| | | | | |
| | Labeling: | YES | NO | COMMENTS |
| | Grounding conductor | | | |
| | End-to-End labeling | | | |
| | Pair Count on Splice Case | | | |
| | Horizontal Cabling | | | |
| | Fiber Optic Cabling | | | |
| | Other: | YES | NO | COMMENTS |
| | Appropriate fire stop material in place | | | |

| | | | | |
|-----------------------------|--|--|--|--|
| | Cabling test results submitted with proper information | | | |
| | Climate controlled environment (Temp. & Humidity) | | | |
| | Is the room access controlled | | | |
| Copper Cabling: | | | | |
| | Total Pairs (Riser) | | | |
| | Pair Counts | | | |
| | Termination Type (66, 110, Protectors..) | | | |
| | Termination Location | | | |
| Fiber Optic Cabling: | | | | |
| Multimode: | | | | |
| | Total Strands | | | |
| | Termination Type (LC, SC) | | | |
| | Termination Location | | | |
| Single Mode: | | | | |
| | Total Strands | | | |
| | Termination Type (LC, SC) | | | |
| | Termination Location | | | |

End of Appendix

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SECTION 272100
DATA COMMUNICATION NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide the Local Area Network (LAN) active components and interfaces to be implemented and utilized in the Houston Airport System network to support present and future communications systems requirements.
- B. Provide HAS wireless connectivity for all new construction and/or remodel.

1.2 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Related Work:
 - 1. Section 270553: Identification and Labeling of Communication Infrastructure
 - 2. Section 271100 Communication Cabinets and Equipment Rooms
 - 3. Section 271300: Backbone and Riser Media Infrastructure
 - 4. Section 271500: Horizontal Media Infrastructure
 - 5. Section 270528: Interior Communication Pathways
 - 6. Section 270543: Exterior Communication Pathways
 - 7. Section 270526: Telecommunications Grounding and Bonding
 - 8. Section 272200: PC, Laptop, and Server Equipment
- D. Conflicts.
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 - 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- E. References:
 - 1. National Electrical Manufacturers Association (NEMA)
 - 2. American Society for Testing Materials (ASTM)
 - 3. National Electric Code (NEC)
 - 4. Institute of Electrical and Electronic Engineers (IEEE)
 - 5. UL Testing Bulletin
 - 6. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps

1.3 DEFINITIONS

- A. *ANSI* – American National Standards Institute

- B. *ATM* – Asynchronous Transfer Mode
- C. *EIA* – Electronics Industries Alliance
- D. *Gbps* – Gigabits per second
- E. *IEEE* – Institute of Electrical and Electronic Engineers
- F. *ISO* – International Organization for Standardization
- G. *Mbps* – Megabits Per Second
- H. *MIMO* – Multiple-In and Multiple-Out
- I. *Multi-path* – The possible multiple routes of a single source of RF energy due to reflection, refraction, or diffraction.
- J. *NEC* – National Electrical Code
- K. *NEMA* – National Electrical Manufacturing Association
- L. *RF* (Radio Frequency) – Signal generated by a radio transmitter and sent out through an antenna. The frequency of the transmission is described in terms of the number of cycles per second or Hertz (Hz).
- M. *SFP* – Small Form-Factor Pluggable – Hot-pluggable transceiver used for both telecommunication and data communication applications. Comes in both copper and fiber.
- N. *SNMP* – Simple Network Management Protocol
- O. *TIA* – Telecommunications Industry Association
- P. *TR* – Telecommunications Room
- Q. *UL* – Underwriter’s Laboratories
- R. *VoIP* – Voice over Internet Protocol
- S. *WAP* – Wireless Application Protocol
- T. *WPA/WPA2* – WiFi Protected Access / WiFi Protected Access II – IEEE 802.11i-2004

1.4 DESIGN AND PERFORMANCE STANDARDS

- A. Standards supported should include, but be not limited to, IEEE 802.3, 10BASET, IEEE 802.3u, 100BaseTX, 1000BaseFX, IEEE 802.11, IEEE 802.3ae-2002, Ethernet MIB (RFC 1643), SNMP MIB II (RFC 1213).
- B. All designs must adhere to HAS Cyber Security Standards.

1.5 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.07.A.

- B. Submit Technical Implementation Plan in accordance with 2.06.
- C. Submit manufacturer's technical data for each product provided.
- D. Submit technical and operations manuals. Manuals shall describe function, operation, and programmable parameters for each card and port for each device to be installed. Manuals shall include required maintenance to be performed.
 - 1. Manuals shall describe function, operation, and programmable parameters for each card and port for each device to be installed. Manuals shall include required maintenance to be performed.
 - 2. Manuals shall be suitable for the training of future personnel by the City, and for use as a reference by currently employed personnel in performing work assignments.
- E. As-built documentation. Notes shall be kept during initial installation and shall be made a permanent part of the installation manual pages as required.
- F. For each active device installed, provide a printed configuration including a printout of the device as displayed on the network management system. Printed configuration parameters for each port on the device shall accompany the written report.
- G. Other information in support of the design, fabrication, and installation of the LAN system.
- H. An implementation schedule listing dates for LAN equipment installations for approval by the City Engineer. The dates of LAN equipment installations shall be in accordance with dates for installation of the various special systems and users. It is incumbent upon the LAN implementers to include the dates for special system and user installs into the schedule.
- I. Include spares list to be approved by HAS IT Project Manager for approval.

1.6 CONTRACTOR'S DUTIES

- A. Perform all work, coordination, systems integration, engineering design, and testing, and shall provide all products required in order to ensure a fully operative system and proper installation of equipment. System operability and proper installation shall be verified via completion of the acceptance test plan.
- B. Coordinate all installation activities and details with the Houston Airport Systems' Information Technology (HAS IT) Representative. The HAS IT Representative shall be responsible for approving the final configuration of all equipment supplied as part of this specification.
- C. Provide all system documentation and submittals.
- D. Provide warranty and maintenance support as specified.
- E. Provide all calculations and/or analysis to support design and engineering decisions as specified in Submittals.
- F. Provide and pay for all labor, materials, and equipment. Pay required sales, gross receipts, and other taxes.
- G. Secure and pay for plan check fees, permits, fees, and licenses necessary for execution of Work as applicable for the project.
- H. Give required notices.

- I. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.7 QUALITY ASSURANCE

A. Contractor Qualifications:

1. The contractor must be certified by the manufacturer of the products to be installed adhere to the engineering, installation and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
2. All members of the installation team must be certified by the manufacturer(s) as having completed the necessary training to complete their part of the installation.
3. Contractor shall provide five references for projects of approved equivalent scope, type and complexity of work completed within the last five years.

- B. Equipment and materials supplied for the LAN shall be a standard product of manufacturers regularly engaged in the manufacture and installation of information backbone technologies and shall be the manufacturer's latest standard design. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of the FCC (Federal Communications Commission) Title CFR 47 Part 15.

- C. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the "contemporary technical equivalent" of that specified. "Contemporary technical equivalent" shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the City.

1.8 MAINTENANCE AND SUPPORT

- A. Provide the manufacturer's standard maintenance and support services for all hardware and software associated with this system at no additional charge for a period of not less than three years. It will be the responsibility of the HAS IT Representative to provide the operational maintenance and support of the installed system. Coordination through the City Engineer and the HAS IT Representative shall be required by the installation contractor to ensure that all documentation for the manufacturer's maintenance and support programs are in place.
- B. All lead technicians performing installation shall have a minimum of two years experience on the proposed system and be manufacturer certified on all hardware/software applications.

1.9 EXTENDED WARRANTY

- A. Provide the manufacturer's warranty for all equipment installed at no additional charge for a period of not less than three years. The warranty shall ensure that the installed equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. The warranty shall allow for replacement or repair at the discretion of the City Engineer and shall include all upgrades for firmware and/or operating systems.
- B. Software License

1. Required software licenses shall be identified and supplied by the Contractor. Licenses shall be "Site Licenses" which shall cover all equipment installed now or in the future.
2. All software licenses and warranties shall be registered in the name of Houston Airport System.

1.10 PROCUREMENT

- A. Procure equipment specified in this document as dictated by the timeline in Appendix B in order to make sure that the technology is acquired in a timely fashion, but not outdated by the installation date.
- B. Submit a copy of Appendix B "Technology Implementation Schedule" as a part of the equipment submittals required elsewhere in this document. The Contractor shall complete the columns headed "Quantity", "Procurement Lead Time", "Start Date or Dependent", and "Installation Duration".
- C. The "Procurement Lead Time" shall be expressed in days or weeks, and shall include time required for the contractor's personnel to order and receive the material. Substantiation may be required.
- D. "Start Date or Dependent" and "Installation Duration" should be an accurate estimate based upon known facts in the project. Substantiation may be required.
- E. The Contractor shall not purchase any materials requiring submittals until the HAS IT approves the submittal for that material and the Technology Implementation Schedule.
- F. The Contractor shall not purchase any materials requiring submittals until the date established by the HAS IT as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the "Purch Auth" column of Appendix B as a part of the Submittal Review process.

1.11 BUY AMERICAN COMPLIANCE

- A. The Contractor shall comply with the applicable FAA Buy American Preference requirements set forth in Title 49 of the United States Code § 50101, BABA and other related Made in America Laws, US statutes, guidance, and FAA Policies which provide that federal funds may not be obligated unless all iron, steel, and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list. If the contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification under such regulations.

PART 2 - PRODUCTS

2.1 EQUIPMENT MANUFACTURERS

- A. LAN Equipment: Unless otherwise specified, furnish products manufactured by Cisco Systems. Substitutions for specified Cisco Systems components are NOT permitted.
- B. Uninterruptible Power Supply (UPS): Eaton or submitted and approved equivalent.
- C. Workstations: Reference Specification 272200 – PC, Laptop and Server Equipment.
- D. Network Printers: Reference Specification 272200 - PC, Laptop and Server Equipment.

- E. Wireless Access Point: Aruba or submitted and approved equivalent.
- F. Wireless Access Point Enclosure: American Access Technologies, Inc. or submitted and approved equivalent.
- G. For cabinets/racks and cabling infrastructure: Reference Specification 271100 – Cabinets and Equipment Rooms.
- H. Courtesy Phone: CEECO or submitted and approved equivalent.
- I. Cat 6 Media extenders Veracity Global or submitted and approved equivalent.

2.2 GENERAL LAN REQUIREMENTS

- A. The LAN configuration shall be a hierarchical star utilizing centralized core switches that star out to individual edge level devices located throughout the premises in designated areas. Single Mode Fiber Optic Cable (provided in Section 271300) provides the connectivity between all devices. Each edge level device services the HAS communications equipment (Administrative LAN workstations, building management stations, etc.) via UTP Copper Cabling.
- B. All LAN equipment shall provide Internet Protocol (IP) switching across all types of network technologies and topologies, including Ethernet, Fast Ethernet and Gigabit Ethernet.
- C. The LAN architecture shall be based on 10 Gbps between the two core networking switches located in the MDF and the edge level networking equipment located in the TR. In addition, the edge level equipment shall be dual homed to the separate core devices where applicable.
- D. Each active device shall be accessible from a network, console or auxiliary RS-232 port. A configuration specialist shall be able to enter supervisory mode and change default configurations as appropriate for required operation of special system components.
- E. Each active device shall be capable of generating Simple Network Management Protocol (SNMP) or SNMP3 alarms. The device shall be respondent to RMON inquiries from an expert level network management inquirer.
- F. All network equipment shall be compliant to physical and operational parameters. The equipment shall be capable of responding to SNMP, SNMP3 and/or RMON network management program calls from the Network Management System.
- G. Network equipment shall provide multimedia and multicast support through use of Protocol Independent Multicast (PIM), Internet Group Management Protocol (IGMP).
- H. Network equipment shall support full-duplex connectivity on links (10Base-TX, 100Base-TX, 1000Base-TX, 100Base-F/TX, and 1000Base-FX).
- I. All fiber interfaces on network switches must support Digital Optical Monitoring (DOM) feature.
- J. All network equipment shall be Virtual Local Area Network (VLAN) compatible based on both port and MAC addresses. VLAN assignments shall be configurable from a centralized administrative console.
- K. Network equipment shall not require re-configuration of end-station network interface cards or network interface card drivers to accommodate intra-VLAN and inter-VLAN traffic.
- L. Network equipment shall support automated VLAN creation and administration capabilities.

- M. Network equipment shall support port mirroring. This shall be done by sending frames directly from a specified port to another switch port or from an external network analyzer.
- N. Network equipment for use in the main MDF and TRs shall belong to one family of product. The equipment must allow for common sparing of all Interface Processor Modules and all Supervisor Modules.
- O. Network equipment shall support Terminal Access Controller Access Control System (TACACS), in order to provide secure port filtering. The equipment must enable individual ports to allow access only to certain workstations.
- P. All active LAN devices shall include all software as required for interconnectivity. All active devices shall have fully functional network management options installed.
- Q. No equipment shall be purchased if it is on the manufacture's "end of life" or "end of support list" in the next year.

2.3 LAN HARDWARE REQUIREMENTS

- A. All equipment shall be rack mountable in standard 19-inch racks. Contractor is responsible for providing fans, shelves, drawers, special power wiring, ground connections, and adapters of any kind necessary to accommodate the system installation, operation, testing, or maintenance. Contractor shall provide the appropriate factory or custom rack mount adapters for all equipment installed in the equipment rack, whether specifically itemized or not. Contractor shall cover unused slots using blank panels.
- B. Fiber and Copper Patch Cords – Adequately sized fiber and copper patch cords shall be provided for each installed port in the LAN under Section 271500, "Horizontal Media Infrastructure."
- C. Core Networking Equipment
 - 1. The core layer networking equipment shall be located in the MDF as shown in the contract drawings.
 - 2. The chassis shall accommodate a minimum of nine (9) interface modules and provide connectivity to mixed network topologies. The use of a chassis is to support networking topologies without the use of external bridges or routers. The chassis shall have redundant power supplies, in the form of hot-swappable modules which can equally share the chassis power load. If one power supply fails the system shall notify the network manager and also provide a display on the front of the chassis. The chassis shall support quality of service through support of IP Precedence, Resource Reservation Protocol (RSVP), and 802.1p.
 - 3. The switch backplane shall provide a minimum of 1440 Gbps switching fabric on the network bus.
 - 4. The chassis shall include modules with a minimum of 24 Gigabit Ethernet (single mode fiber) ports to be connected to distribution layer switches in the Terminal MDFs.
 - 5. The chassis shall support:
 - a. Redundant supervisor modules.
 - b. Hot swappable line cards.
 - c. Layer 2 and Layer 3 IP switching.
 - d. Up to 192 10 Gigabit or 25 Gigabit Ethernet ports.
 - e. Support broadcast suppression.
 - f. Support IGMP snooping and pruning.
 - 6. The core switching equipment shall, at a minimum, a Cisco Catalyst 9606 with the following modules:
 - a. Two Supervisor modules(C9600-SUP-1/2).
 - b. 48-port 25/10/1 Gigabit Ethernet module(s) with enough SFP/+ ports to support the connectivity requirements for core to core and core to distribution switch

uplinks(C9600-LC-48YL). All ports shall include Long Wavelength / Long Haul (25/10/1 Gigabit LX/LH) SFPs (single-mode).

- c. Four 2000W AC power supplies (C9600-PWR-2KWAC).
- d. Software License - DNA Advantage 3 Year (C9600-DNA-A-3Y)
- e. Smart License – Prime Infrastructure Lifecycle Smart License (PI-LFAS-T)
- f. License – Prime Infrastructure Lifecycle 3 Years Term (PI-LFAS-AP-T-3Y)

D. Edge Level Equipment

1. The edge level networking equipment shall be located in the individual TR as shown in the contract drawings unless noted otherwise.
2. The devices shall provide a minimum of 10 Gbps switching fabric.
3. The device shall include a module(s) with the appropriate RJ45 Category 6 UTP 10/100/1000BaseTX ports to support the port requirements shown on the contract drawings. In addition, the device shall have the capability to “stack” with additional devices to increase the available port count.
4. The edge level devices shall have the capability to simultaneously accommodate a minimum of two Gigabit Ethernet uplinks and 24 10/100/1000 VoIP Ethernet ports.
5. The devices shall support the bonding and trunking of Fast Ethernet and Gigabit Ethernet ports.
6. The edge level switching equipment shall be Cisco Catalyst C9300-24U-E or submitted and owner-approved equivalent. Use 24 port switch if 16 ports or less are active. Upgrade to the 48 port switch (C9300-48U-E) if more than 16 ports are active. Switches must also come with network module C9300-NM-4G (4 x 1gb), single-mode SFPs, and three year term license (C9300DNA-E-24-3Y for 24 port and C9300DNA-E-48-3Y for 48 port). Switches are to be ordered with the following power supply - PWR-C1-1100WAC – 1100W AC power supply.
7. The edge level equipment for industrial environment applications shall be Cisco IE-3200-8P2S-E or submitted and owner-approved equivalent. The switch supports 8 POE/POE+ copper connections and 2 SFP ports for uplinks. Power supply to be provided is PWR-IE170W-PC-AC=.

2.4 UPS HARDWARE REQUIREMENTS

- A. Room wide UPS is the preferred type of UPS for all Telecommunications rooms. Eaton model 93PM for all three-phase UPS applications. The three-phase UPSs shall not be installed in IDF/MDFs. The electrical engineer must size the UPS for 25 percent future growth and must be approved by HAS Technology project manager. The preferred UPS design is two or more centralized UPSs in parallel for redundancy and ease of maintenance. UPS power distribution (depending on application) shall be 480v and step down to 240v at the nearest electrical room nearest the IDF. Unit must have enough batteries to keep all equipment attached to the unit running for minimum of one (1) hour.
 1. Lithium batteries are to be installed.
 2. External maintenance bypass switch must also be installed along with the UPS.
 3. The optional Energy Saver System(ESS) shall be provided.
 4. Environmental Probe Gen 2(EMP Gen2) shall be provided.
 5. Eaton gigabit network card(Network-M2) shall be provided.
- B. If a room wide UPS is not installed provide a rack-mounted UPS in equipment cabinet in the Telecommunications Room that houses LAN equipment. The UPS shall have an output capacity of 5KVA (3750 Watts). All remaining TRs shall be supported by a UPS as well. Unit must have enough batteries to keep all equipment attached to the unit running for minimum of one (1) hour. If specified UPS cannot be installed due to space restraints a smaller UPS (Eaton 5PX1500RTN) can be substituted if submitted and owner-approved prior to installation, runtime requirements and environmental probe are still required.

- C. The UPS interface port shall have an RS-232 communications port and a 10/100 Base-T Ethernet for LAN management. Include optional environmental probe (Eaton part # 42R4317).
- D. The control panel shall have a LED status display for load and battery bar-graphs in addition to replace battery and overload indicators.
- E. The Output Connections shall include as a minimum one NEMA L6-30R, two NEMA L6-20R, and eighteen NEMA 5-15R.
- F. Input connection shall be nominal 208 V via L6-30P plug.
- G. Include software and interface card to provide Web/SNMP management through 10/100Base-T Ethernet port. Management software shall include the following attributes:
 - 1. Shall allow complete configuration of the UPS devices from a remote location
 - 2. Shall provide periodic UPS self-tests
 - 3. Shall provide full control over UPS transfer settings
 - 4. Shall provide user name and password security
 - 5. Shall log all power events with a description
- G. UPS shall be Eaton 9PX5KTF5 5000VA RM 5U 208V series with Web / SNMP Management Card for Ethernet and optional environmental probe, or submitted and owner-approved equivalent.

2.5 WIRELESS ACCESS POINT

- A. General: One 802.11ax Wireless Access Point shall be installed per the Drawings.
- B. INDOOR Access Points
 - 1. AP-630 series specifications
 - a. AP-635
 - b. 2.4- GHz (287 Mbps max), 5-GHz (1.2 Gbps max) and 6-GHz (2.4 Gbps max) radios (total 3.9 Gbps).
 - 2. AP type: Indoor, tri radio, 6 GHz 802.11ax, 5 GHz 802.11ax and 2.4 GHz 802.11ax
 - 3. 4x4 MIMO with three spatial streams and up to 1.733 Gbps wireless data rate
 - 4. Supported frequency bands:
 - a. 2.4000 GHz to 2.4835 GHz
 - b. 5.150 GHz to 5.250 GHz
 - c. 5.250 GHz to 5.350 GHz
 - d. 5.470 GHz to 5.725 GHz
 - e. 5.725 GHz to 5.850 GHz
 - f. 5.850 to 5.895 GHz U-NII-4
 - g. 5.925 to 6.425 GHz U-NII-5
 - h. 6.425 to 6.525 GHz U-NII-6
 - i. 6.525 to 6.875 GHz U-NII-7
 - j. 6.875 to 7.125 GHz U-NII-8
 - 5. Available channels: Dependent upon configured regulatory domain
 - 6. Dynamic frequency selection (DFS) optimizes the use of available RF spectrum
 - 7. Supported radio technologies:
 - a. 802.11b: Direct-sequence spread-spectrum (DSSS)
 - b. 802.11a/g/n/ac: Orthogonal frequency-division multiplexing (OFDM)
 - c. 802.11n/acv2: 4x4 MIMO with up to three spatial streams
 - 8. Supported modulation types:
 - a. 802.11b: BPSK, QPSK, CCK

- b. 802.11a/g/n: BPSK, QPSK, 16-QAM, 64-QAM
- c. 802.11ac: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM
- 9. Transmit power: Configurable in increments of 0.5 dBm
- 10. Maximum (aggregate, conducted total) transmit power (limited by local regulatory requirements):
 - a. 2.4-GHz band: +23 dBm (18 dBm per chain)
 - b. 5-GHz bands: +23 dBm (18 dBm per chain)
- 11. Advanced cellular coexistence (ACC) feature to effectively deal with interference from cellular systems
- 12. Maximum ratio combining (MRC) for improved receiver performance
- 13. Cyclic delay diversity (CDD) for improved downlink RF performance
- 14. Short guard interval for 20-MHz, 40-MHz and 80-MHz channels
- 15. Space-time block coding (STBC) for increased range and improved reception
- 16. Low-density parity check (LDPC) for high-efficiency error correction and increased throughput
- 17. Transmit beam-forming (TxBF) for increased reliability in signal delivery
- 18. Supported data rates (Mbps):
 - a. 802.11b: 1, 2, 5.5, 11
 - b. 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54
 - c. 802.11n: 6.5 to 450 (MCS0 to MCS23)
 - d. 802.11ac: 6.5 to 1,300 (MCS0 to MCS9, NSS = 1 to 3)
- 19. 802.11n high-throughput (HT) support: HT 20/40
- 20. 802.11acv2 very high throughput (VHT) support: VHT 20/40/80/160
- 21. 802.11n/acv2 packet aggregation: A-MPDU, A-MSDU

C. Power

- 1. Maximum power consumption: 25.3 watts, plus up to 5.9 watts for attached USB device and internal overhead.
- 2. Power sources sold separately
- 3. Direct DC source: 12 Vdc nominal, +/- 5%
- 4. Power over Ethernet (PoE): 48 Vdc (nominal) 802.3af or 802.3at-compliant source
 - a. Efficient mode PoE – power save with 802.3af PoE and limited functionality
 - 1) USB port disabled
 - 2) Second Ethernet port disabled
 - 3) 2.4-GHz 802.11n radio in 1x3:1 spatial-stream mode
 - 4) 5-GHz 802.11ac radio operates without restrictions*
 - b. Unrestricted functionality with 802.3at PoE+
- 5. *With ArubaOS software 6.3.0, the 5-GHz 802.11ac radio operates in 2x3:2 spatial stream mode when the AP is powered by 802.3af PoE. This restriction has been removed in 6.3.1.

D. Antennas

- 1. AP-334: Four RP-SMA connectors for external dual-band antennas. Internal loss between radio interface and external antenna connectors (due to diplexing circuitry): 1.5 dB in 2.4 GHz and 3.0 dB in 5 GHz.
- 2. AP-335: Eight integrated down-tilt omni-directional antennas for 4x4 MIMO with maximum antenna gain of 3.5 dBi in 2.4 GHz and 4.5 dBi in 5 GHz. Built-in antennas are optimized for horizontal ceiling mounted orientation of AP-335.

E. Other interfaces

1. Two 10/100/1000BASE-T Ethernet network interfaces (RJ-45)
 - a. Auto-sensing link speed and MDI/MDX
 - b. Load balancing support to achieve platform throughput greater than 1 Gbps
 - c. 802.3az Energy Efficient Ethernet (EEE)
 - d. PoE-PD: 48 Vdc 802.3af PoE or 802.3at PoE+
2. DC power interface, accepts 1.7/4.0mm center-positive circular plug with 9.5 mm length.
3. USB 2.0 port (Type A connector)
4. Serial console interface (RJ-45, TTL levels)
5. Visual indicators (LEDs):
 - a. Power/system status
 - b. Ethernet link status (2x; ENET0, ENET1)
 - c. Radio status (2x; RAD0, RAD1)
6. Bluetooth Low Energy (BLE) radio
 - a. --Up to 4 dBm transmit power (class 2) and -91 dBm receive sensitivity
 - b. --Integrated antenna with roughly 30 degrees downtilt and peak gain of 5.1 dBi (AP-334/IAP-334) or 2.2 dBi (AP-335/IAP-335)
7. Kensington security slot
8. Reset button

F. Mounting

1. Included with AP:
 - a. Mounting brackets (2) for attaching to 9/16-inch or 15/16-inch T-bar drop-tile ceiling
2. Optional mounting kits:
 - a. AP-220-MNT-C2: Aruba 220 series AP mount kit contains two ceiling-grid rail adapters for Interlude and Silhouette style rails.
 - b. AP-220-MNT-W1: Aruba 220 series AP mount kit contains one flat-surface wall/ceiling mount bracket.
 - c. AP-220-MNT-W2: Aruba 220 series AP mount kit contains one flat-surface wall/ceiling secure mount cradle.

G. Mechanical

1. Dimensions/weight (unit, excluding mount accessories):
 - a. 203 mm (W) x 203 mm (D) x 54 mm (H), 8.0" (W) x 8.0" (D) x 2.1" (H)
 - b. 750 g/27 oz
2. Dimensions/weight (shipping):
 - a. 315 mm (W) x 265 mm (D) x 100 mm (H), 12.4" (W) x 10.4" (D) x 3.9" (H)
 - b. 1,250 g/44 oz

H. Environmental

1. Operating:
 - a. Temperature: 0° C to +50° C (+32° F to +122° F)
 - b. Humidity: 5% to 95% non-condensing
2. Storage and transportation:
 - a. Temperature: -40° C to +70° C (-40° F to +158° F)

I. Regulatory

1. FCC/Industry of Canada
2. CE Marked
3. R&TTE Directive 1995/5/EC

4. Low Voltage Directive 72/23/EEC
5. EN 300 328
6. EN 301 489
7. EN 301 893
8. UL/IEC/EN 60950
9. EN 60601-1-1 and EN 60601-1-2

J. Regulatory Model Numbers

1. AP-334 and IAP-334: APIN0334
2. AP-335 and IAP-335: APIN0335

K. Certifications

1. CB Scheme Safety, cTUVus
2. UL2043 plenum rating
3. Wi-Fi Alliance certified 802.11a/b/g/n/ac

L. Warranty

1. Limited lifetime warranty

M. Minimum operating system software versions

1. ArubaOS 6.3.0.0
2. Aruba Instant 4.0.0.0

N. RF Performance Table

| | Maximum transmit power (dBm) per transmit chain | Receiver sensitivity (dBm) per receive chain |
|--|---|--|
| 802.11b 2.4 GHz | | |
| 1 Mbps | 18.0 | -92.0 |
| 2 Mbps | 18.0 | -92.0 |
| 5.5 Mbps | 18.0 | -90.0 |
| 11 Mbps | 18.0 | -88.0 |
| 802.11g 2.4 GHz and 802.11a 5 GHz | | |
| 6 Mbps | 18.0 | -88.0 |
| 54 Mbps | 16.0 | -75.0 |
| 802.11n HT20 2.4 GHz and 5 GHz | | |
| MCS0/8 | 18.0 | -88.0 |
| MCS7/15 | 14.0 | -71.0 |
| 802.11n HT40 2.4 GHz and 5 GHz | | |
| MCS0/8 | 18.0 | -85.0 |
| MCS7/15 | 14.0 | -68.0 |
| 802.11ac VHT20 5 GHz | | |
| MCS0 | 18.0 | -88.0 |
| MCS9 | 12.0 | -65.0 |
| 802.11ac VHT40 5 GHz | | |
| MCS0 | 18.0 | -85.0 |
| MCS9 | 12.0 | -62.0 |
| 802.11ac VHT80 5 GHz | | |
| MCS0 | 18.0 | -82.0 |
| MCS9 | 12.0 | -59.0 |

O. Enclosures

1. Wireless Access Points shall be installed in lockable, stainless steel Nema 4 Enclosure when mounted outdoors or in garage spaces.
2. Include back-plate, ground bus-bar, cable management, document holder, pole/wall mount adapters.
3. Provide 120VAC@15A quad receptacle with surge protection per drawings.

4. Enclosure shall be bonded to ground per NEC.
5. All conduit penetrations shall be made to prevent water ingress through the connections.
6. Enclosure size per drawings.

P. Wireless Access Point Ceiling Enclosure

1. The 802.11ac wireless access point shall be installed in a lockable enclosure mounted to the ceiling. The enclosure shall meet the following specifications:
 - a. Enclosure shall be Oberon Wireless model # 1075-WA or submitted and owner approved equivalent.
 - b. The WAP is installed in such a manner that the antennas, or face of WAP if antennas are integrated, are largely within the ABS plastic dome; there is little impact on WAP coverage with antennas largely inside dome
 - c. Back-box is 16 ga. aluminum; door and bezel are textured, white powder-coated steel; RoHS compliant
 - d. Dome is 10" x 10" x 1 1/2"; textured white ABS dome (-WA) is UL 94-5VA classified, and clear polycarbonate dome (-CP) is UL 94-5VB classified
 - e. Size: Bezel is 15" x 15", back-box is 12 3/4" x 12 3/4" x 3" deep
 - f. Knockouts for AC receptacle, (2) keystone jacks, (2) 3/4" trade conduit connector
 - g. Maximum weight to be installed inside the unit is 25 lbs.
 - h. De-rate upper operating temperature limit from +50°C to +40°C when AP in the enclosure
 - i. Enclosure must be supported by the tile bridges; when installed in the ceiling, enclosure must be supported by the building structure, independent of the suspended ceiling

2.6 OUTDOOR ACCESS POINTS

A. AP-570 series specifications

1. AP-575 and IAP-575
 - a. 2.4-GHz and 5-GHz radios, each with Multi-User MIMO and three integrated omnidirectional antennas
2. AP-574 and IAP-574
 - a. 2.4-GHz and 5-GHz radios, each with Multi-User MIMO and three combined, diplexed external antenna connectors

B. Wireless radio specifications

1. AP type: Outdoor, dual radio, 5-GHz 802.11ax and 2.4-GHz 802.11ax
2. Supported frequency bands (country-specific restrictions apply):
 - a. 2.4000 GHz to 2.4835 GHz
 - b. 5.150 GHz to 5.250 GHz
 - c. 5.250 GHz to 5.350 GHz
 - d. 5.470 GHz to 5.725 GHz
 - e. 5.725 GHz to 5.875 GHz
3. Available channels: Dependent upon configured regulatory domain
4. Dynamic frequency selection (DFS) optimizes the use of available RF spectrum
5. Supported radio technologies:
 - a. 802.11b: Direct-sequence spread-spectrum (DSSS)
 - b. 802.11a/g/n/ac: Orthogonal frequency-division multiplexing (OFDM)
 - c. 802.11n/ac: 4x4 MIMO with up to three spatial streams
 - d. 802.11ax: Wi-Fi 6 dual radio, 5 GHz 4x4 MIMO and 2.4 GHz 2x2 MIMO
6. Supported modulation types:
 - a. 802.11b: BPSK, QPSK, CCK

- b. 802.11a/g/n: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM (with TurboQAM clients)
- c. 802.11ac: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM
- d. 802.11ax: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024 QAM
- 7. Transmit power: Configurable in increments of 0.5 dBm
- 8. Maximum (aggregate, conducted total) transmit power (limited by local regulatory requirements):
 - a. 2.4-GHz band: +28 dBm (23 dBm per chain)
 - b. 5-GHz bands: +28 dBm (23 dBm per chain)
- 9. Advanced cellular coexistence (ACC) feature to minimize interference from cellular systems
- 10. Maximum ratio combining (MRC) for improved receiver performance
- 11. Cyclic delay diversity (CDD) for improved downlink RF performance
- 12. Short guard interval for 20-MHz, 40-MHz, 80-MHz and 160-MHz channels
- 13. Space-time block coding (STBC) for increased range and improved reception
- 14. Low-density parity check (LDPC) for high-efficiency error correction and increased throughput
- 15. Explicit transmit beam-forming (TxBF) for increased reliability in signal delivery
- 16. Supported data rates (Mbps):
 - a. 802.11b: 1, 2, 5.5, 11
 - b. 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54
 - c. 802.11n (2.4GHz): 6.5 to 300 (MCS0 to MCS15, HT20 to HT40)
 - d. 802.11n (5GHz): 6.5 to 600 (MCS0 to MCS31, HT20 to HT40)
 - e. 802.11ac: (5 GHz): 6.5 to 3,467 (MCS0 to MCS9, NSS = 1 to 4 for VHT20 to VHT160)
 - f. 802.11ax (2.4GHz): 8.6 to 574 (MCS0 to MCS11, NSS = 1 to 2, HE20 to HE40)
 - g. 802.11ax (5GHz): 8.6 to 4803 (MCS0 to MCS11, NSS = 1 to 4, HE20 to HE160) 802.11ac very high throughput (VHT) support: VHT 20/40/80/160
- 17. 802.11n/ac packet aggregation: A-MPDU, A-MSDU Power
 - a. Maximum (conducted) transmit power (limited by local regulatory requirements):
 - 1) 2.4 GHz band: +22 dBm per chain, +25dBm aggregate (2x2)
 - 2) 5 GHz band: +22 dBm per chain, +28dBm aggregate (4x4)
 - 3) Note: conducted transmit power levels exclude antenna gain.
- 18. Power over Ethernet (PoE): 48 Vdc (nominal) 802.3at-compliant source
- 19. Bluetooth 5 and 802.15.4 radio
 - a. 2.4 GHz
 - b. Bluetooth 5: up to 8dBm transmit power and -95 dBm receive sensitivity
 - c. Zigbee: up to 8 dBm transmit power and -97 dBm receive sensitivity
 - d. Up to 4 dBm transmit power (class 2) and -91 dBm receive sensitivity Antennas
- 20. AP-574: Six N-type female connectors for external antennas
- 21. AP-575: Built in omni-directional antennas for 4x4 MIMO with maximum antenna gain of 5 dBi in 2.4 GHz and 5 dBi in 5 GHz. Built-in antennas are optimized for horizontal mounted orientation of AP-575.

C. Other interfaces

- 1. One PoE+ PD port 10/100/1000BASE-T Ethernet network interface (RJ-45)
- 2. One port 100/1000BASE-T (RJ-45)
- 3. AC power interface, power cords sold separately
- 4. Serial console interface (USB-C)
- 5. Reset button
- 6. Visual indicator (LED):
 - a. Power/system status; automatically disabled after initial operation period

D. Mounting

- 1. Must be ordered separately
- 2. Optional mounting kits:

- a. AP-270-MNT-V1: Aruba 270 series AP long mount kit for pole/wall mounting. Reduces impact of obstruction by pole or extends away from corner.
- b. AP-270-MNT-V2: Aruba 270 series AP short mount kit for pole/wall mounting

E. Mechanical AP-274

1. Dimensions/weight (excluding mount):
 - a. 23 cm (W) x 24 cm (D) x 19 cm (H) with aesthetic cover
 - b. 9.0" (W) x 9.4" (D) x 7.5" (H)
 - c. 2.7 kg/6 lbs
 - d. 23 cm (W) x 24 cm (D) x 14 cm (H) without aesthetic cover
 - e. 9.0" (W) x 9.4" (D) x 5.5" (H)
 - f. 2.4 kg/5.3 lbs

F. Mechanical AP-275

1. Dimensions/weight (excluding mount):
 - a. 23 cm (W) x 24 cm (D) x 27 cm (H)
 - b. 9.0" (W) x 9.4" (D) x 10.6" (H)
 - c. 2.4 kg/5.3 lbs

G. Environmental

1. Operating:
 - a. Temperature: -40° C to +65° C (-40° F to +150° F)
 - b. Humidity: 5% to 95% non-condensing
2. Storage and transportation:
 - a. Temperature: -40° C to +70° C (-40° F to +158° F)
3. Operating Altitude: 3000m
4. Chassis Rating: IP66 and IP67
5. Wind Survivability: Up to 165 mph
6. Shock and Vibration: ETSI 300-19-2-4 spec T41.E 4M3

H. Regulatory

1. FCC/Industry of Canada
2. CE Marked
3. R&TTE Directive 1995/5/EC
4. Low Voltage Directive 72/23/EEC
5. EN 300 328
6. EN 301 489
7. EN 301 893
8. UL/IEC/EN 60950
9. EN 60601-1-1, EN60601-1-2

I. Regulatory Model Numbers

1. AP-274 and IAP-274: APEX0101
2. AP-275 and IAP-275: APEX0100

J. Certifications

1. CB Scheme Safety, cTUVus
2. UL2043 plenum rating
3. Wi-Fi Alliance certified 802.11a/b/g/n/ac

K. Warranty

1. Limited lifetime warranty

L. Minimum operating system software versions

1. ArubaOS 6.4
2. Aruba Instant 4.1 (planned availability mid 2014)

M. RF Performance Table

| | Maximum transmit power (dBm) per transmit chain | Receiver sensitivity (dBm) per receive chain |
|--|---|--|
| 802.11b 2.4 GHz | | |
| 1 Mbps | 23.0 | -92.0 |
| 2 Mbps | 23.0 | -92.0 |
| 5.5 Mbps | 23.0 | -90.0 |
| 11 Mbps | 23.0 | -88.0 |
| 802.11g 2.4 GHz and 802.11a 5 GHz | | |
| 6 Mbps | 23.0 | -88.0 |
| 54 Mbps | 18.0 | -75.0 |
| 802.11n HT20 2.4 GHz and 5 GHz | | |
| MCS0/8 | 23.0 | -88.0 |
| MCS7/15 | 17.0 | -71.0 |
| 802.11n HT40 2.4 GHz and 5 GHz | | |
| MCS0/8 | 23.0 | -85.0 |
| MCS7/15 | 17.0 | -68.0 |
| 802.11ac VHT20 5 GHz | | |
| MCS0 | 23.0 | -88.0 |
| MCS9 | 16.0 | -65.0 |
| 802.11ac VHT40 5 GHz | | |
| MCS0 | 23.0 | -85.0 |
| MCS9 | 16.0 | -62.0 |
| 802.11ac VHT80 5 GHz | | |
| MCS0 | 23.0 | -82.0 |
| MCS9 | 16.0 | -59.0 |

N. Enclosures

1. Wireless Access Points shall be installed in lockable, stainless steel Nema 4 Enclosure when mounted outdoors or in garage spaces.
2. Include back-plate, ground bus-bar, cable management, document holder, pole/wall mount adapters.
3. Provide 120VAC@15A quad receptacle with surge protection per drawings.
4. Enclosure shall be bonded to ground per NEC.
5. All conduit penetrations shall be made to prevent water ingress through the connections.
6. Enclosure size per drawings.

O. Lightning arrestors

1. AP-LAR-1 N-type male to N-type female in-line lightning surge arrestor (2GHz-6GHz). (AP-274 ONLY).

P. Installation materials

1. AINS2KKIT-00 Optional Weather proofing materials: Suggested for antenna end connections only. (AP-274 ONLY).

Q. RF cables for non-direct mount of antenna (optional) (AP-274 ONLY).

1. AP-CBL-1 For remoting omnis or antennas with pigtails
2. ANT-CBL-1 1m Flexible Cable
3. ANT-CBL-2 2m Flexible Cable
4. AFC7DL03-01 3m Low loss cable. AP-LAR-1 recommended
5. AFC7DL04-01 4m Low loss cable. AP-LAR-1 recommended

R. Antenna for Radio 0 (5 GHz) (AP-274 ONLY)

1. ANT-3x3-5005 MIMO, Omni, 5 dBi, 5 GHz, Direct mount to chassis or remoted with N male to N female cable (x3)
2. ANT-3x3-5010 MIMO, Omni, 10 dBi, 5 GHz, Direct mount to chassis or remoted with N male to N female cable (x3)
3. ANT-2x2-5314 MIMO, Sector 30° x 30°, 14 dBi, 5 GHz, Requires N male to N male cables (x2)
4. ANT-3x3-5712 MIMO, Sector 70° x 25°, 12 dBi, 5 GHz, Requires N male to N male cables (x3)
5. ANT-3x3-D608 MIMO, Sector 60°, 2.4/5 GHz, Requires N male to N male cables (x3)
6. ANT-3x3-D905 MIMO, Sector 90°, 2.4/5 GHz, Requires N male to N male cables (x3)

S. Antenna for Radio 1 (2.4 GHz) (AP-274 ONLY)

1. ANT-3x3-2005 MIMO, Omni, 5 dBi, 2.4 GHz, Direct mount to chassis or remoted with N male to N female cable (x3)
2. ANT-2x2-2314 MIMO, Sector 30° x 30°, 14 dBi, 2.4 GHz, Requires N male to N male cables (x2)
3. ANT-2x2-2714 MIMO, Sector 70°, 14 dBi, 2.4 GHz, Requires N male to N male cables (x2)
4. ANT-3x3-D608 MIMO, Sector 60°, 2.4/5 GHz. Requires N male to N male cables (x3)
5. ANT-3x3-D905 MIMO, Sector 90°, 2.4/5 GHz. Requires N male to N male cables (x3)

T. AP mount kit

1. AP-270-MNT-V1 Aruba 270 Series Access Point Long Mount Kit. Pole/Wall Mount for P-270 300 mm from vertical mounting asset.
2. AP-270-MNT-V2 Aruba 270 Series Access Point Short Mount Kit. Pole/Wall Mount for AP-270 75-mm from vertical mounting asset.

U. Ethernet Surge Protection Device (SPD)

1. Use in field for outdoor applications. Device shall be rated for outdoor use.
 - a. Transtector 1101-935(Gigabit POE) No exceptions.
 - b. Transtector ALPU-L130(Gigabit POE+) No exceptions.
 - c. Transtector ALPU-F140(Gigabit POE++) No exceptions.

2.7 Ethernet and PoE+ Extension Unit

- A. The Enable-IT™ 828 Gigabit Ethernet and PoE+ Extension Unit.

2.8 PoE + POWER Injector

- A. Enable-IT 360 60W- 56VDC IEEE 802.3AT Gigabit PoE + Injector.

2.9 Mobility controller

- A. Aruba Networks

1. Aruba Model 7200 Series Mobility Controllers. Refer to drawings for Qty.

| Model Number Aruba 7200 Controller | Number of APs Supported |
|------------------------------------|-------------------------|
| 7240 | 2048 |

B. Front Panel

1. The front panel of the Aruba 7200 mobility controller contains the following components:
 - a. Four 10GBase-X (SFP+) ports
 - b. Two Dual-Media Ports
 - c. LINK/ACT and Status LEDs
 - d. Management/Status LED
 - e. LCD Panel and Navigation Buttons
 - f. Console Connections - RJ-45 and Mini-USB
 - g. Expansion Slot (reserved for future use)

C. Physical

1. Device Dimensions (without mounting brackets) (HxWxD)
 - a. All Models: 1.75" x 17.5" x 17.5"
 - b. All Models: 4.4 cm x 44.5 cm x 44.5 cm
2. Device Weight (with one AC power supply installed)
 - a. All Models: 16.43 lbs (7.45 kg)

D. Power Supply Specifications

1. 350W AC Power Supply
 - a. AC Input Voltage: 100 VAC to 240 VAC
 - b. AC Input Current: 5-2.5A
 - c. AC Input Frequency: 50 - 60 Hz
 - d. Weight: 2.8 lbs (1.3 kg)

E. Operating Specifications

1. Operating Temperature Range: 0°C to 40°C (32°F to 104°F)
2. Operating Humidity Range: 5% to 95% (RH), non-condensing

F. Package Checklist

1. Inform your supplier if there are any incorrect, missing, or damaged parts. If possible, retain the carton, including the original packing materials (see Table). Use these materials to repack and return the unit to the supplier if needed.

| Item | Quantity |
|---|----------|
| Aruba 7200 Series Controller | 1 |
| Power Supply Unit - Installed | 1 |
| Fan Tray - Installed | 1 |
| Expansion Slot Cover - Installed | 1 |
| Blank Panel over unpopulated PSU Intake - Installed | 1 |
| Rack Mounting Brackets | 2 |
| M6 x 15mm Rack Mounting Screws | 4 |
| M4 x 6mm Rack Mount Bracket Screws | 8 |
| USB Console Cable | 1 |
| Power Cable | 1 |
| Aruba 7200 Series Installation Guide (Printed) | 1 |
| End User License Agreement (Printed) | 1 |
| Aruba Document Pointer (Printed) | 1 |

2.10 ClearPass Policy Manager

- A. ClearPass Policy Manager-5000. Refer to drawings for Qty.
1. Aruba ClearPass Policy Manager 5K hardware platform supporting a maximum of 5,000 authenticated devices.
 2. Appliance Specifications:
 - a. CPU - (1) Quad Core Xeon
 - b. Memory - 8 GB
 3. Hard drive storage:
 - a. (2) 3.5" SATA (7.2K RPM) 500GB hard drives, RAID-1 controller
 4. Appliance Scalability:
 - a. Maximum devices - 5,000
 5. Form Factor:
 - a. Dimensions (W x H x D) - 17.53" x 1.7" x 16.8"
 - b. Weight (max config) - 18 Lbs
 6. Power:
 - a. Power consumption (maximum) - 250 watts max
 - b. Power supply - Single
 - c. AC input voltage - 110/220 VAC auto-selecting
 - d. AC input frequency - 50/60 Hz auto-selecting

2.11 LAN PERFORMANCE REQUIREMENTS

- A. The wired system shall perform as designed providing a minimum of 10/100/1000 Mbps to each end user device and 1Gbps from edge switch to core switch on the backbone.

2.12 TELEPHONE SYSTEM HARDWARE REQUIREMENTS

A. Courtesy Telephones

1. Courtesy Telephone stations shall be class of service restricted to internal calls only, i.e. no local, collect, long distance toll (1+), toll free, (800, 888, 877, 866), operator assisted (0,0+), or directory assistance (411, 555-1212, etc.) calls shall be allowed.
2. Each Courtesy Telephone shall be capable of dialing 9+911 for an emergency and have the capacity to dial six-digit internal directory numbers (DN).
3. Each Courtesy Telephone shall transmit its DN to internal called parties.
4. Each Courtesy Telephone shall have a call party name display (CPND) associated with its DN.
5. Each Courtesy Telephone shall be manufactured by CEECO:
 - a. Model SSW-321-F-ACHW-PBVC-C
 - b. CALL RESTRICT Stainless steel wall telephone, chrome tone dial, MCRK-2 P.C. board, Lexan 32" armored cord, WHITE handset, pushbutton volume control and confidence. CAC 6.00 software.
 - c. 301-037 Security tool – 5/32" #9020 BLUE. Required for installation.
 - d. CEEC Contact – pmccreary@ceeco.net – 1-888-357-0798
6. Courtesy Phone Stainless Steel Backboards
 - a. "COURTESY PHONE" Letters 1-1/4" Height Helvetica Medium engraved and painted black.
 - b. Distributed by Volume Millwork Inc.
 - c. Part#: 10-SPTELLETTTE
 - d. Description: Courtesy Tellette
 - e. Contact: Edwin Chatoor– (713) 538-1451 - robin@vmillwork.com
 - f. Must be lockable using key (contractor to request in writing from HAS Technology what key the lock shall be keyed to)

B. VOIP PHONES

1. DESK PHONE
 - a. CISCO 8841 Telephone Set
 - 1) NO APPROVED SUBSTITUTE.
2. CONFERENCE TABLE PHONE
 - a. CISCO 8831 Conference Telephone Set (Includes Control Units & Mic Kits)
 - 1) NO APPROVED SUBSTITUTE.
3. Basic Telephone Set (lobby, breakroom, ticket counter)
 - a. Cisco 7811 Basic Telephone Set
 - 1) NO APPROVED SUBSTITUTE.

C. SOFT PHONE (Software based telephone; still requires license.)

1. CISCO Jabber
 - 1) NO APPROVED SUBSTITUTE.

D. LICENSES

1. CISCO Professional (Knowledge Worker) A-FLEX-P-PRO
2. CISCO Enhanced (task Worker/Common Area) A-FLEX-P-ENH
3. Provide license for each device and/or softphone application for 100% functionality and integration into the HAS VoIP phone system.

E. HEADSETS / ACCESSORIES

1. Jabra Biz 2400 II Mono 3-1 GSA (for soft phone). GSA2406-820-205
2. Jabra 1200 Smartcord 6 ft coil cord. 88011-99
3. Engage 65 Mono Convertible (use with phone & computer). 9555-553-125
 - a. Include EHS cable with each unit. Jabra EHS Cable for Cisco, 14201-43.

2.13 CAT 6 Media extender

A. Manufactured by Veracity Global

1. Model – Outreach Max XT
 - a. POE/POE + compatible
 - b. IP 66 rating
 - c. Can be wall mounted but preferred method is inside of a NEMA enclosure
 - d. RJ45 connectors

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components in accordance with contract drawings, manufacturer's instructions and approved submittal data.
- B. System installation and construction methods shall conform to the requirements of the Federal Communications Commission.
- C. The Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and adjustments required for a complete and operable system.
- D. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- E. The HAS IT Representative shall perform final configuration of the network equipment. This includes, but is not limited to: VLAN configuration, IP addressing schemas, final port assignments, and trunking/bonding configurations. Installation contractor shall ensure that the proper documentation is provided to assist in the final system configuration.
- F. The Contractor shall coordinate with the cabling contractor with the installation if the iPatch/imVision crossconnect panel to create a true cross-connect per iPatch/imVision standards.

3.2 PRODUCT HANDLING

- A. The Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the City.

3.3 HARDWARE INSTALLATION

- A. The Contractor shall obtain written permission from the City Engineer before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the City Engineer before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.
- B. The Contractor shall take all steps necessary to ensure that all public areas remain clear or are properly marked during installation or maintenance.
- C. The Contractor shall develop a detailed network map to be utilized as a road map during the implementation of the LAN. This map shall show all segments, all interconnects between segments and all active network devices. This network map shall not include the individual nodes interconnected to each concentrator, but will have the modules, interfaces, protocols, addresses and other identifying features for each concentrator and other active device.
- D. The Contractor shall also develop a Cable Plant interconnectivity chart showing all fiber patch panels and individual identifiers for each fiber associated with the interconnectivity of each network device.
- E. Prior to installing Wireless Access Points, conduct and document an RF site survey to determine the maximum operating range between an AP (fixed location) and mobile stations for a specified transmit power level. Survey shall also identify holes of coverage due to multi-path, interference sources, and interference from other wireless installations.
- F. The contractor shall place materials only in those locations that have been previously approved. The City Engineer shall approve any other locations, in writing.

3.4 SYSTEM STARTUP

- A. The Contractor shall not apply power to the system until after:
 - 1. System and components have been installed and inspected in accordance with the manufacturer's installation instructions.
 - 2. A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 - 3. System wiring has been tested and verified as correctly connected as indicated.
 - 4. All system grounding and transient protection systems have been verified as properly installed and connected, as indicated.
 - 5. The City Engineer and the HAS IT Representative have approved the installation.
- B. Satisfaction of the above requirements shall not relieve the contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of contractor's deficient work/defective equipment.

3.5 ACCEPTANCE TESTING

- A. The contractor shall develop and execute an onsite acceptance-testing program.
- B. The plan shall address all requirements identified in this specification and test all contractor supplied cabling and hardware components. The plan shall follow accepted industry testing practices and have a method of independent verification described.

- C. Any specified item that does not satisfy the requirements of this specification shall be replaced, upgraded, or added by the contractor as necessary to correct the noted deficiencies. After correction of a noted deficiency, re-testing shall be performed to verify the effectiveness of the corrective action.

3.6 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. **Any deviation from the specification must be approved by HAS IT prior to installation.**

END OF SECTION

APPENDIX A

LAN Equipment Schedule (EXAMPLE)

| Item | Qty |
|---|-----|
| COMM ROOM 11611 | |
| WS-C3650-24PS | 3 |
| GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode | 6 |
| COMM ROOM 11715 | |
| WS-C3650-24PS | 1 |
| GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode | 2 |
| COMM ROOM 11908 | |
| WS-C3650-24PS | 2 |
| GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode | 4 |
| COMM ROOM 12015 | |
| WS-C3650-24PS | 1 |
| GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode | 2 |
| COMM ROOM 11812 | |
| WS-C3650-24PS | 2 |
| GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode | 4 |
| COMM ROOM 12606 | |
| WS-C3650-24PS | 3 |
| GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode | 6 |
| MDF | |
| WS-X6848-SFP-2T (for 6509) | 4 |
| GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode | 36 |
| WS-X6824-SFP-2T (for 6509) | 2 |

GUIDELINES

HAS/IT/Design Division
Houston, Texas

Project Title
Proj./CIP No.

(NOTE TO DESIGNER/SPECIFIER: These Guidelines are basic minimum criteria to be met in preparing the final specifications for this section, which is the responsibility of the Designer.)

APPENDIX B

TECHNOLOGY IMPLEMENTATION SCHEDULE (EXAMPLE)

| | (from Designer) | | (Contractor Submittal) | | | (Submittal Response) | | | |
|----|--|------------|------------------------|-----------------------|-------------------------|-----------------------|--------------------|--------------|---------|
| | Product Description | Spec. Ref. | Qty. | Procurement Lead Time | Start Date or Dependent | Installation Duration | Submittal Approved | Purch. Auth. | Remarks |
| 1 | WS-C3650-24PS | 2.04.D | | | | | | | |
| 2 | GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode | 2.04.D | | | | | | | |
| 3 | WS-X6824-SFP-2T (for 6509) | 2.04.C | | | | | | | |
| 4 | General Workstation | 2.04.G | | | | | | | |
| 5 | Network Printer | 2.04.H | | | | | | | |
| 6 | Cisco Wireless Access Point | 2.04.I | | | | | | | |
| 7 | Wireless Access Point Enclosure | 2.04.J | | | | | | | |
| 8 | Cisco 16-port 10 Gigabit Ethernet Copper Module with DFC4 WS-X6816-10T-2T | 2.04.E | | | | | | | |
| 9 | Cisco 48-port SFP fiber Gigabit Ethernet Module with DFC4 WS-X6848-SFP-2T | 2.04.E | | | | | | | |
| 10 | Cisco Gigabit Ethernet Module WSX6848-GE-TX | 2.04.E | | | | | | | |
| 11 | | 2.04.E | | | | | | | |
| 12 | Cisco IOS® Software Release 15.05Y or higher | 2.04.E | | | | | | | |

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