

Project Manual

## Construction Documents

# Ridgeview Elementary School Renovations

701 Thornton Street  
Liberty, Missouri 64068

Prepared For:

**Liberty School District**  
8 Victory Lane  
Liberty, Missouri 64068

HM Project No: 23026  
Issue Date: November 22, 2023

### **Contents:**

Volume 1: Introductory Information, Bidding and Contracting Requirements,  
Division 2 through Division 12  
Volume 2: Division 22 through Division 28



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## **SECTION 000101 - PROJECT TEAM DIRECTORY**

### **PART 1 - GENERAL**

#### **1.1 CONSTRUCTION MANAGER INFORMATION**

- A. Newkirk Novak Construction Partners has been selected as the Construction Manager for this project, and as such, will act as the Owner's representative.
- B. All communication, both written and oral, must be directed through the Construction Manager.

#### **1.2 PROJECT TEAM INFORMATION**

- A. **PROJECT:**
  - 1. Name: 23026 LPS Aging Facilities Ridgeview Elementary
  - 2. Location: 701 Thornton Street, Liberty, Missouri 64068
  - 3. Project No: 23026
- B. **OWNER:**
  - 1. Name: Liberty Public Schools
  - 2. Address: 8 Victory Lane, Liberty, Missouri 64068
  - 3. Contact: Justin Presson
  - 4. Phone: 816.736.5448
- C. **CONSTRUCTION MANAGER:**
  - 1. Name: Newkirk Novak Construction Partners
  - 2. Address: 11200 W. 79th Street, Lenexa, Kansas 66241
  - 3. Contact: Brandon Stanley
  - 4. Email: Brandon.Stanley@newkirknovak.com
  - 5. Phone: 913.312.9535.
- D. **ARCHITECT:**
  - 1. Name: Hollis + Miller Architects, Inc.
  - 2. Address: 1828 Walnut Street, Suite 922, Kansas City, MO 64108.
  - 3. Contact: Nicole Rezai
  - 4. Email: Nrezai@hollisandmiller.com
  - 5. Phone: 816.442.7700 / Fax: 816.599.2545
- E. **STRUCTURAL ENGINEER:**
  - 1. Name: Bob D. Campbell & Co.
  - 2. Address: 4338 Belleview Ave, Kansas City, Missouri 64111.
  - 3. Contact: Wayne Davis
  - 4. Email: wdavis@bdc-engrs.com
  - 5. Phone: 816.531.4114 / Fax: 816.531.8572
- F. **MEP ENGINEER:**
  - 1. Name: Henderson Engineering Inc.
  - 2. Address: 8345 Lenexa Drive, Suite 300, Lenexa, KS 66214
  - 3. Contact: Allen Evans
  - 4. Email: allen.evans@hendersonengineers.com
  - 5. Phone: 913.742.5000

### **PART 2 - PRODUCTS (NOT USED)**

### **PART 3 - EXECUTION (NOT USED)**

### **END OF SECTION**

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**SECTION 000105 - CERTIFICATIONS PAGE**

ARCHITECT

I HEREBY, PURSUANT TO RSMO 327.411, STATE THAT THE SPECIFICATIONS INTENDED TO BE AUTHENTICATED BY MY SEAL ARE LIMITED TO SPECIFICATIONS LISTED BELOW:

DIVISION 1 SECTIONS:	011000, 012100, 012200, 012300, 012500, 013100, 013200, 013233, 013300, 014000, 014200, 014529, 016000, 017310, 017419, 017419, 017700, 017823, 017839, 017900.
DIVISION 2 SECTION:	024119.
DIVISION 6 SECTIONS:	061000, 061600, 064023.
DIVISION 7 SECTIONS:	072500, 076200, 078413, 078446, 079200.
DIVISION 8 SECTIONS:	081113, 081416, 083113, 084113, 085613, 087100, 088000.
DIVISION 9 SECTIONS:	092116, 092900, 093000, 095113, 096513, 096519, 096723, 096813, 099123, 099600.
DIVISION 10 SECTIONS:	101423, 102113, 102123, 102600, 102800.
DIVISION 12 SECTIONS:	123200, 123666.

I HEREBY DISCLAIM ANY RESPONSIBILITY FOR ALL OTHER SPECIFICATIONS, DRAWINGS, ESTIMATES, REPORTS, OR OTHER DOCUMENTS OR INSTRUMENTS RELATING TO OR INTENDED TO BE USED FOR ANY PART OR PARTS OF THE ARCHITECTURAL OR ENGINEERING PROJECT OR SURVEY.

KEVIN NELSON

NOVEMBER 22, 2023

ARCHITECT

DATE



NOVEMBER 22, 2023



**SECTION 000105 - CERTIFICATIONS PAGE**

STRUCTURAL ENGINEER

I HEREBY, PURSUANT TO RSMO 327.411, STATE THAT THE SPECIFICATIONS INTENDED TO BE AUTHENTICATED BY MY SEAL ARE LIMITED TO SPECIFICATIONS LISTED BELOW:

DIVISION 3 SECTIONS: 033000

DIVISION 4 SECTIONS: 042200

DIVISION 5 SECTIONS: 051200, 053100, 054000

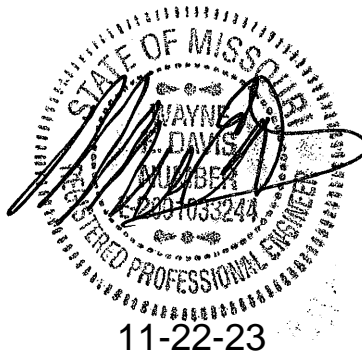
I HEREBY DISCLAIM ANY RESPONSIBILITY FOR ALL OTHER SPECIFICATIONS, DRAWINGS, ESTIMATES, REPORTS, OR OTHER DOCUMENTS OR INSTRUMENTS RELATING TO OR INTENDED TO BE USED FOR ANY PART OR PARTS OF THE ARCHITECTURAL OR ENGINEERING PROJECT OR SURVEY.

WAYNE E. DAVIS

11/22/2023

STRUCTURAL ENGINEER

DATE





**DOCUMENT 000105 – CERTIFICATIONS AND SEALS**

Engineer:

I hereby state, that the Specifications intended to be authenticated by my seal are limited to Specification Sections listed below:

Division 26 Sections: 260000, 260010, 260500, 260502, 250504, 250510, 260519, 260526, 250529, 260533,  
260553, 260913, 262416, 262726, 262813, 262816, 265100  
Division 28 Sections: 280010, 280501, 281000, 281010, 281300

I hereby disclaim any responsibility for all other specifications, drawings estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of the architectural or engineering project or survey.

\_\_\_\_\_  
Engineer

\_\_\_\_\_  
Date



11/10/2023



**DOCUMENT 000105 – CERTIFICATIONS AND SEALS**

Engineer:

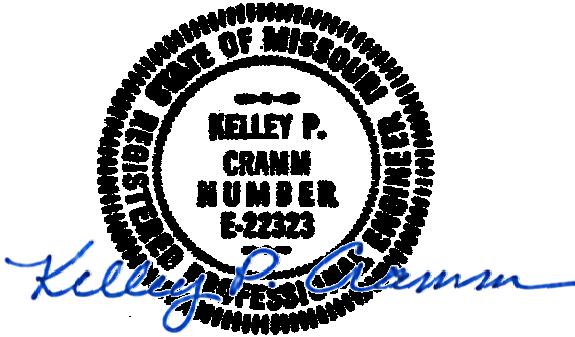
I hereby state, that the Specifications intended to be authenticated by my seal are limited to Specification Sections listed below:

Division 22 Sections: 220010, 220010, 220015, 220500, 220515, 220523, 220529, 220553, 220700, 221100, 221111, 221300, 224000, 227000, 227010  
Division 23 Sections: 230010, 230015, 230500, 230513, 230514, 230519, 230523, 230529, 230550, 230553, 230593, 230700, 230913, 230923, 232113, 232114, 232123, 233113, 233300, 233423, 233713, 237313, 237433, 238200

I hereby disclaim any responsibility for all other specifications, drawings estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of the architectural or engineering project or survey.

\_\_\_\_\_  
Engineer

\_\_\_\_\_  
Date



11/10/2023





**DOCUMENT 000105 – CERTIFICATIONS AND SEALS**

Engineer:

I hereby state, that the Specifications intended to be authenticated by my seal are limited to Specification Sections listed below:

Division 28 Sections: 284600

I hereby disclaim any responsibility for all other specifications, drawings estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of the architectural or engineering project or survey.

\_\_\_\_\_  
Engineer

\_\_\_\_\_  
Date



11/20/2023



## DOCUMENT 000110 – TABLE OF CONTENTS

Project Name: Ridgeview Elementary School Renovations  
Project No.: 23026  
Site Address: 701 Thornton Street, Liberty, Missouri 64068  
City, State Zip: Liberty, Missouri 64068

Revisions	Date

Latest Revision Original Issue

### INTRODUCTORY INFORMATION

000101	Project Team Directory	11.22.2023
000105	Certifications and Seals	11.22.2023
000110	Table of Contents	11.22.2023

### BIDDING REQUIREMENTS

(Refer to Construction Manager's Front End Manual for additional Bidding Requirements)

### DIVISION 1 – GENERAL REQUIREMENTS

011000	Summary	11.22.2023
012100	Allowances	11.22.2023
012200	Unit Prices	11.22.2023
012300	Alternates	11.22.2023
012500.1	Substitution Procedures	11.22.2023
012500.2	Substitution Procedures Form	11.22.2023
013100	Project Management and Coordination	11.22.2023
013200	Construction Progress Documentation	11.22.2023
013233	Photographic Documentation	11.22.2023
013300	Submittal Procedures	11.22.2023
014000	Quality Requirements	11.22.2023
014200	References	11.22.2023
014529	Testing and Inspections	11.22.2023
016000	Product Requirements	11.22.2023
017310	Cutting and Patching	11.22.2023
017419	Construction Waste Management and Disposal	11.22.2023
017700	Closeout Procedures	11.22.2023
017823	Operation and Maintenance Data	11.22.2023
017839	Project Record Documents	11.22.2023
017900	Demonstration and Training	11.22.2023

### DIVISION 2 – EXISTING CONDITIONS

024119	Selective Demolition	11.22.2023
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### DIVISION 3 – CONCRETE

033000	Cast-in-Place Concrete	11.22.2023
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### DIVISION 4 - MASONRY

042200	Concrete Unit Masonry	11.22.2023
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### DIVISION 5 - METALS

051200	Structural Steel Framing	11.22.2023
053100	Steel Decking	11.22.2023
054000	Cold-Formed Metal Framing	11.22.2023

**DIVISION 6 – WOOD AND PLASTICS**

061000	Rough Carpentry	11.22.2023
061600	Sheathing	11.22.2023
064023	Interior Architectural Woodwork	11.22.2023

**DIVISION 7 - THERMAL AND MOISTURE PROTECTION**

072500	Weather Barriers	11.22.2023
076200	Sheet Metal Flashing and Trim	11.22.2023
078413	Penetration Firestopping	11.22.2023
078446	Fire Resistive Joint Systems	11.22.2023
079200	Joint Sealants	11.22.2023

**DIVISION 8 - DOORS AND WINDOWS**

081113	Hollow Metal Doors and Frames	11.22.2023
081416	Flush Wood Doors	11.22.2023
083113	Access Doors and Frames	11.22.2023
084113	Aluminum Framed Entrances and Storefronts	11.22.2023
085613	Transaction Windows	11.22.2023
087100	Door Hardware	11.22.2023
088000	Glazing	11.22.2023

**DIVISION 9 - FINISHES**

092116	Non-Structural Metal Framing	11.22.2023
092900	Gypsum Board	11.22.2023
093000	Tiling	11.22.2023
095113	Acoustical Panel Ceilings	11.22.2023
096513	Resilient Base and Accessories	11.22.2023
096519	Resilient Tile Flooring	11.22.2023
096723	Resinous Flooring	11.22.2023
096813	Tile Carpeting	11.22.2023
099123	Interior Painting	11.22.2023
099600	High-Performance Coatings	11.22.2023

**DIVISION 10 – SPECIALTIES**

101423	ADA and Code Signage	11.22.2023
102113	Toilet Compartments	11.22.2023
102123	Cubicle Curtains and Track	11.22.2023
102600	Wall and Door Protection	11.22.2023
102800	Toilet, Bath & Laundry Accessories	11.22.2023

**DIVISION 12 - FURNISHINGS**

123200	Manufactured Wood Casework	11.22.2023
123666	Solid Surfacing Countertops	11.22.2023

**DIVISION 22 - PLUMBING**

220010	General Plumbing Requirements	11.22.2023
220015	Coordination	11.22.2023
220500	Common Work Results for Plumbing	11.22.2023
220515	Basic Piping Materials and Methods	11.22.2023
220523	General Duty Valves for Plumbing Piping	11.22.2023
220529	Hangers and Supports for Plumbing Piping	11.22.2023
220553	Identification for Plumbing Piping and Equipment	11.22.2023
220700	Plumbing Insulation	11.22.2023

	Latest Revision	Original Issue
221100	Water Distribution Piping and Specialties	11.22.2023
221111	Mechanically Joined Plumbing Piping Systems	11.22.2023
221300	Sanitary Drainage and Vent Piping Specialties	11.22.2023
224000	Plumbing Fixtures	11.22.2023
227000	Natural Gas Systems	11.22.2023
227010	Mechanically Joined Natural Gas Piping Systems	11.22.2023

#### DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

230010	General Mechanical Requirements	11.22.2023
230015	Electrical Coordination for Mechanical Equipment	11.22.2023
230500	Common Work Results for HVAC	11.22.2023
230510	Basic Piping Materials and Methods	11.22.2023
230513	Common Motor Requirements for HVAC Equipment	11.22.2023
230514	Variable Frequency Drives	11.22.2023
230519	Meters and Gages for HVAC Piping	11.22.2023
230523	General Duty Valves for HVAC Piping	11.22.2023
230529	Hangers and Supports for HVAC Piping and Equipment	11.22.2023
230550	Vibration Isolation for HVAC	11.22.2023
230553	Identification for HVAC Piping and Equipment	11.22.2023
230593	Testing, Adjusting, and Balancing for HVAC	11.22.2023
230700	HVAC Insulation	11.22.2023
230913	Instrumentation and Control Devices for HVAC	11.22.2023
230923	Direct Digital Control (DDC) System for HVAC	11.22.2023
232113	Hydronic Piping	11.22.2023
232114	Hydronic Specialties	11.22.2023
232123	Hydronic Pumps	11.22.2023
233113	Metal Ducts	11.22.2023
233300	Air Duct Accessories	11.22.2023
233423	HVAC Power Ventilators	11.22.2023
233713	Diffusers, Registers, and Grilles	11.22.2023
237313	Central-Station Air Handling Units	11.22.2023
237433	Dedicated Outdoor-Air Units	11.22.2023
238200	Terminal Heating & Cooling	11.22.2023

#### DIVISION 26 - ELECTRICAL

260010	General Electrical Requirements	11.22.2023
260500	Common Work Results for Electrical	11.22.2023
260502	Equipment Wiring Systems	11.22.2023
260504	Provisions for Electrical Utility Service	11.22.2023
260519	Low-Voltage Electrical Power Conductors and Cables	11.22.2023
260526	Grounding and Bonding for Electrical Systems	11.22.2023
260529	Hangers and Supports for Electrical Systems	11.22.2023
260533	Raceway and Boxes for Electrical Systems	11.22.2023
260923	Lighting Control Devices	11.22.2023
262416	Panelboards	11.22.2023
262726	Wiring Devices	11.22.2023
262813	Fuses	11.22.2023
262816	Enclosed Switches and Circuit Breakers	11.22.2023
265100	Interior Lighting	11.22.2023

#### DIVISION 27 – COMMUNICATIONS

270010	General Communications Requirements	11.22.2023
270500	Common Work Results for Communications	11.22.2023

		Latest Revision	Original Issue
271000	Structured Cabling System		11.22.2023
271100	Telecommunications Equipment Room Fittings		11.22.2023
271500	Communications Horizontal Cabling		11.22.2023
274100	Audio Video Systems		11.22.2023

#### DIVISION 28 - ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION

280010	General Electronic Safety and Security Requirements		11.22.2023
280501	Common Work Results for Electronic Security		11.22.2023
281000	Electronic Security Systems		11.22.2023
281010	Conductors and Cables for Electronic Security		11.22.2023
281300	Access Control Software and Database Management		11.22.2023
284600	Fire Detection and Alarm		11.22.2023

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## **SECTION 220010 - GENERAL PLUMBING REQUIREMENTS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 DESCRIPTION OF WORK**

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; 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 materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 22 of the Specifications and Drawings numbered with prefixes P, MP and EP, or MEP generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

#### **1.2 QUALITY ASSURANCE**

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

#### **1.3 CODES, REFERENCES AND STANDARDS**

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code
IMC	International Mechanical Code

IPC	International Plumbing Code
IFGC	International Fuel Gas Code
IECC	International Energy Conservation Code
ADA	American Disabilities Act
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
FGI	Facilities Guideline Institute
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

#### 1.4 DEFINITIONS

##### A. General:

1. Furnish: When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.



- a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
- 9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. The following definitions apply to excavation operations:
  - 1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
  - 2. Bedding: as used in this Section refers to the compacted sand or pea gravel installed in the bottom of a pipe trench to immediately support a pipe and cover a pipe.
  - 3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
  - 4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
  - 5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.
  - 6. Drainage Fill: as used in this Section refers to gravel installed to assist in the removal of underslab groundwater.
  - 7. Building Fill: as used in this section refers to borrowed fill material of rock 1" and larger used to fill foundation excavations.

## 1.5 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.
- D. The contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform

the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

## 1.6 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

## 1.7 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.
  - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
  - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
  - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
  - 4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
  - 5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
  - 6. Indicate required installation sequence to minimize conflicts between entities.
  - 7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
  - 8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
  - 1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
  - 2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
    - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
  - 3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
  - 4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

## 1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website,

user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. Submittals shall contain the following information:
  - 1. The project name.
  - 2. The applicable specification section and paragraph.
  - 3. Equipment identification acronym as used on the drawings.
  - 4. The submittal date.
  - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
  - 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

#### 1.9 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files from the Engineer. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form to Henderson Engineers, Inc. Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

#### 1.10 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
  - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
  - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
  - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
    - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
    - d. Same warranty will be furnished for proposed substitution as for specified Work.
    - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
  - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
  - 2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
  - 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
  - 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

#### 1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain data listed in Table 5.
- F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

#### 1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 2 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.

- B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

#### 1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

#### 1.14 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

#### 1.15 PAINTING

- A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Plumbing Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
- B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.
- C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

#### 1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.
- D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

#### 1.17 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer

warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

- C. The following additional items shall be guaranteed:
  - 1. Piping shall be free from obstructions, holes or breaks of any nature.
  - 2. Insulation shall be effective.
  - 3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

#### 1.18 TEMPORARY FACILITIES

- A. Refer to Division 1 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
  - 1. Water: Premises are supplied with water services which may be used in this work: Contractor shall make his own arrangements for water services.
  - 2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, nonclogged condition during construction period.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
  - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

#### 1.19 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings:
  - 1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting His bid to determine the nature and extent of work involved.
  - 2. Work in the existing building shall be scheduled with the Owner.
  - 3. Certain demolition work must be performed prior to the remodeling. The Plumbing Contractor shall perform the demolition which involves Plumbing and Plumbing systems, fixtures, equipment, piping, equipment supports or foundations and materials.
  - 4. Plumbing Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Plumbing Contractor during this demolition shall become his property and shall be removed by the Plumbing Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
  - 5. Plumbing Contractor shall relocate and reconnect Plumbing facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Plumbing equipment or materials are removed, the Plumbing Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
  - 6. General Contractor shall install finish material.
  - 7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
  - 8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect Plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
  1. Maintain and protect existing building services which transit the area affected by selective demolition.
  2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 SOIL MATERIALS**

- A. Provide clean sand, pea gravel or flowable fill material (per the geotechnical engineer's or structural engineer's recommendations).
- B. Subbase Material: Where applicable, provide natural soils with 10% by volume of rocks less than 2" diameter or artificially crushed aggregate. Corrosive fill materials shall not be utilized. When CL clay, rock, or gravel is used, it shall not be larger than 2 inches in any dimension and be free of debris, waste, frozen materials, vegetable and other deleterious matter.

## **PART 3 - EXECUTION**

### **3.1 PERMITS**

- A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

### **3.2 EXISTING UTILITIES**

- A. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.
- B. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.
- C. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

### **3.3 SELECTIVE DEMOLITION**

- A. Refer to Division 01, Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned Plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing Plumbing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

- E. Plumbing Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
  - 1. Inactive and obsolete piping, fittings and specialties, equipment, controls, fixtures and insulation.
    - a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
    - b. Perform cutting and patching required for demolition in accordance with Division 1, General Conditions and "Cutting and Patching" portion of this Section in Division 22.
- F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
  - 1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

### 3.4 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.
- C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.
- D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.
- E. Erect barricades around excavations. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.
- F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
  - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.
  - 1. Do not allow water to accumulate in excavations and trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
  - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
  - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
  - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Trenching: Excavate trenches for Plumbing installations as follows:
  - 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.



2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
  3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
  4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.
  5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.
- L. Bedding:
1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below:
  2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.
- M. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
  2. Under building slabs, use drainage fill materials.
  3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
  4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support after installation and testing of piping and prior to backfilling and placement of roadway subbase. Coordinate with AHJ for colored concrete requirements.
  5. Other areas, use excavated or borrowed materials.
- N. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
  2. Removal of concrete formwork.
  3. Removal of shoring and bracing, and backfilling of voids.
  4. Removal of trash and debris.
- O. Drainage Fill: Where building fill is used in lieu of natural soils, provide drainage fill as subbase material. Provide filter fabric material to line the trench to support the bedding material and subbase materials to ensure that backfill materials will not segregate within the trench nor create voids and sags within the pipe trench.
- P. Placement and Compaction: Place subgrade backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- S. Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
1. Use of pneumatic backhoe as compaction method is not allowed as an acceptable process for compaction of excavations or trenches.
  2. For vertical and/or diagonal pipe installations greater than ½" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.
  3. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water

- appearing on surface during, or subsequent to, compaction operations. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.
  5. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
    - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
- T. Subsidence: Where subsidence occurs at Plumbing installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.
- U. Additional Excavation: Where additional excavation may be required due to unsuitable bearing materials encountered, notify the architect immediately for resolution.

### 3.5 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.
- G. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

### 3.6 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

### 3.7 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
  - 1. Submit complete Operation and Maintenance Manuals.
  - 2. Submit complete Record Drawings.
  - 3. Start-up testing of systems.
  - 4. Removal of temporary facilities from the site.
  - 5. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

**END OF SECTION 220010**

TABLE 1: PLUMBING SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220010	General Plumbing Requirements	NONE
220015	Coordination	NONE
220500	Common Work Results For Plumbing	A, B, G, M
220515	Basic Piping Materials And Methods	B, G
220523	General-Duty Valves For Plumbing Piping	B
220529	Hangers And Supports For Plumbing Piping	B, F, G, H
220553	Identification For Plumbing Piping & Equipment	B, L, M
220700	Plumbing Insulation	B, M
221100	Water Distribution Piping & Specialties	B, G, H
221111	Mechanically Joined Plumbing Piping Systems	B, G, H
221300	Sanitary Drainage & Vent Piping & Specialties	B
224000	Plumbing Fixtures	B, E, N
227000	Natural Gas Systems	A, B, C, D, F, G
227010	Mechanically Joined Natural Gas Piping Systems	B, F, H, N

## CODED LEGEND

A	Shop Drawings
B	Product Data and equipment weights
C	Performance Data, Curves, Certificates and Test Data
D	Coordination Drawings
E	Wiring Diagrams and short circuit current ratings
F	Installation Instructions
G	Welder's Certificates
H	Certificates
I	Calculations
J	Special Inspections
K	Special Warranties
L	Material Samples
M	Schedules
N	Recommended Spare Parts List

TABLE 2: SPARE PARTS REQUIREMENTS FOR PLUMBING EQUIPMENT

SECTION NUMBER		RECEIVED/DATE/INITIAL
220553	Identification For Plumbing Piping & Equipment	
221100	Water Distribution Piping & Specialties	
221111	Mechanically Joined Plumbing Piping Systems	
224000	Plumbing Fixtures	
227000	Natural Gas Systems	

\_\_\_\_\_  
Owner's Signature

TABLE 3: PLUMBING SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220500	Common Work Results For Plumbing	B
220523	General-Duty Valves For Plumbing Piping	B, H, I
220529	Hangers And Supports For Plumbing Piping	B
220553	Identification For Plumbing Piping & Equipment	B
220700	Plumbing Insulation	B
221100	Water Distribution Piping & Specialties	A, B, F, H, I
221111	Mechanically Joined Plumbing Piping Systems	A, B, F, H, I
221300	Sanitary Drainage & Vent Piping & Specialties	A, B, F
224000	Plumbing Fixtures	B, E, H, I
227000	Natural Gas Systems	A, B, C, H
227010	Mechanically Joined Natural Gas Piping Systems	B, F, H

## CODED LEGEND

A	As-Built Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Wiring Diagrams
E	Operating Instructions
F	Test Reports
G	Warranties
H	Recommended Spare Parts List
I	Service and Maintenance Instructions

## SUBSTITUTION REQUEST FORM

To Project Engineer: \_\_\_\_\_ Request # (GC Determined): \_\_\_\_\_

Project Name: \_\_\_\_\_

Project No/Phase: \_\_\_\_\_ Date: \_\_\_\_\_

Specification Title: \_\_\_\_\_

Section Number: \_\_\_\_\_ Page: \_\_\_\_\_ Article/Paragraph: \_\_\_\_\_

Proposed Substitution: \_\_\_\_\_

Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_

Address: \_\_\_\_\_ Phone: \_\_\_\_\_

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: \_\_\_\_\_

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples  
☐ Tests ☐ Reports ☐ Other: \_\_\_\_\_

Reason for not providing specified item: \_\_\_\_\_

Similar Installation:

Project: \_\_\_\_\_ Architect: \_\_\_\_\_

Address: \_\_\_\_\_ Owner: \_\_\_\_\_

Date Installed: \_\_\_\_\_

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: \_\_\_\_\_

**Substitution Certification Statement:**

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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**Manufacturer's Certification of Equal Quality:**

I \_\_\_\_\_ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
--	---------------	------------------

**Engineer Review and Recommendation Section**

Recommend Acceptance      ☐ Yes      ☐ No  
Additional Comments:      ☐ Attached      ☐ None

**Acceptance Section:**

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company



## **SECTION 220015 - COORDINATION**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.
- C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

#### **1.2 SUBMITTALS**

- A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical components and materials shall be UL labeled.
- B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

### **PART 2 - PRODUCTS AND MATERIALS**

#### **2.1 GENERAL**

- A. The Contractors shall provide all wire, conduit, etc. as specified in the Construction Documents. If, however, the Plumbing Contractor furnishes a piece of equipment requiring a different wire size, etc. than what is shown and/or intended on the Construction Documents, the Plumbing Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.
- B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections
- C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

### **PART 3 - EXECUTION**

#### **3.1 CONTRACTOR COORDINATION**

- A. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

#### **END OF SECTION 220015**

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## **SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:
  - 1. Access panels and doors in walls, ceilings, and floors for access to Plumbing materials and equipment.
  - 2. Plumbing equipment nameplate data.
  - 3. Non-shrink grout for equipment installations.
  - 4. Sleeves for Plumbing penetrations.
  - 5. Miscellaneous metals for support of Plumbing materials and equipment.
  - 6. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.
  - 7. Joint sealers for sealing around Plumbing materials and equipment.
  - 8. Plenum insulation for enclosure of combustible items located within fire-rated return air plenums.
- B. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
  - 2. Division 22 Section "Basic Piping Materials and Methods" for materials and methods for mechanical sleeve seals.
  - 3. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for indirect drain piping and installation requirements.
  - 4. Division 26 Section "Common Work Results for Electrical" required electrical devices.
  - 5. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

#### **1.2 SUBMITTALS**

- A. General: Submit the following in accordance with Division 1 and Division 22 Section "General Plumbing Requirements".
  - 1. Product data for the following products:
    - a. Access panels and doors.
    - b. Through and membrane-penetration firestopping systems.
    - c. Joint sealers.
  - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.
  - 3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
  - 4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
    - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."
  - 5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
    - a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

#### **1.3 QUALITY ASSURANCE**

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
  - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
  - 1. Provide UL Label on each fire-rated access door.

- C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 ACCESS TO EQUIPMENT**

- A. Manufacturer:
1. Bar-Co., Inc.
  2. Elmdor Stoneman.
  3. JL Industries
  4. Jay R. Smith Mfg. Co.
  5. Karp Associates, Inc.
  6. Milcor
  7. Nystrom Building Products
  8. Wade
  9. Zurn
- B. Access Doors:
1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Plumbing Piping" for labeling of access doors.
  2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
  3. Access doors must be of the proper construction for type of construction where installed.
  4. The exact location of all access doors shall be verified with the Architect prior to installation.
  5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
  6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
    - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
    - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
    - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
  7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
    - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
  8. Locking Devices: Flush, screwdriver-operated cam locks.

### **2.2 PLUMBING EQUIPMENT NAMEPLATE DATA**

- A. For each piece of power operated Plumbing equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

### **2.3 GROUT**

- A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.
- B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.
- C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

## 2.4 PENETRATIONS

- A. Sleeves:
  - 1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
  - 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
- B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.
- C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

## 2.5 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

## 2.6 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWP rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

## 2.7 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
  - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
    - a. "Dow Corning 790," Dow Corning Corp.
    - b. "Silglaze II SCS 2801," General Electric Co.
    - c. "Silpruf SCS 2000," General Electric Co.
    - d. "864," Pecora Corp.
    - e. "Rhodia 5C," Rhone-Poulenc, Inc.
    - f. "Spectrem 1," Tremco, Inc.
    - g. "Spectrem 2," Tremco, Inc.
    - h. "Dow Corning 795," Dow Corning Corp.
    - i. "Rhodia 7B," Rhone-Poulenc, Inc.
    - j. "Rhodia 7S," Rhone-Poulenc, Inc.

- k. "Omniseal," Sonneborn Building Products Div.
  - 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
    - a. "Dow Corning 786," Dow Corning Corp.
    - b. "Sanitary 1700," General Electric Co.
    - c. "898 Silicone Sanitary Sealant," Pecora Corp.
- D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Chem-Calk 600," Bostik Construction Products Div.
    - b. "AC-20," Pecora Corp.
    - c. "Sonolac," Sonneborn Building Products Div.
    - d. "Tremflex 834," Tremco, Inc.

## 2.8 PLENUM INSULATION

- A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated return air plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.
- B. Material: FyreWrap 0.5 Plenum Insulation, ETS Schaefer Plenumshield Blanket, or equivalent utilizing light weight, high temperature blanket enhanced for biosolubility. The encapsulating material shall be aluminum foil with fiberglass reinforcing scrim covering.
- C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.
- D. Physical Properties: Plenum insulation shall be single ½" layer with a density of 6 to 8 pounds per cubic foot.

## 2.9 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:
  - 1. 3M Corp., Fire Barrier Sealant
  - 2. Hilti
  - 3. Owens Corning, Firestopping Insulation.
  - 4. Pecora, AC-20 FTR
  - 5. RectorSeal
  - 6. Specified Technologies Inc.,
  - 7. United States Gypsum Company SHEETROCK Firecode Compound
  - 8. Tremco, Tremstop Fyre-Sil.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION, GENERAL

- A. Install access doors and sealants in accordance with manufacturer's installation instructions.

### 3.2 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

### 3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

### 3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### 3.5 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

### 3.6 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
  - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
  - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

### 3.7 PENETRATIONS:

- A. New Construction:
  - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.
- B. Construction in Existing Facilities:
  - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
- C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.
- D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.
- E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

- F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Extend sleeves installed in floors 2 inches above finished floor level.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.
- K. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section "Basic Piping Materials and Methods".

### 3.8 PLENUM INSULATION

- A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated return air plenums where permitted by the local authority having jurisdiction
- B. Overlap: Provide a minimum 1" perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.
- C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer's written installation instructions.
- D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated return air plenums where the use of plenum insulation is not approved.

### END OF SECTION 220500



## **SECTION 220515 - BASIC PIPING MATERIALS AND METHODS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.
- B. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 22 Section "Common Work Results for Plumbing," for materials and methods for sleeve materials.

#### **1.2 DEFINITIONS**

- A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content  $\leq 0.25\%$  per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

#### **1.3 SUBMITTALS**

- A. Refer to Division 1 and Division 22 Section "General Plumbing Requirements" for administrative and procedural requirements for submittals.
- B. Product Data: Submit product data on the following items:
  - 1. Escutcheons
  - 2. Dielectric Unions
  - 3. Dielectric Waterway Fittings
  - 4. Dielectric Flanges and Flange Kits
  - 5. Wall Pipes
  - 6. Strainers
- C. Quality Control Submittals:
  - 1. Submit welders' certificates specified in Quality Assurance below.
- D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.
- E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.
- F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

#### **1.4 QUALITY ASSURANCE**

- A. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.
- B. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 MANUFACTURERS**

- A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:
  - 1. Pipe Escutcheons:
    - a. AWI Manufacturing.
    - b. Keeney Manufacturing Company
    - c. Wal-Rich Corp.
    - d. Jones Stephens Corp.
  - 2. Dielectric Waterway Fittings:
    - a. Grinnell Mechanical Products; Tyco Fire Products LP
    - b. Precision Plumbing Products, Inc.
  - 3. Dielectric Unions:
    - a. JOMAR International
    - b. Smith Cooper International
    - c. Watts Regulator Co.
    - d. Zurn Industries
  - 4. Dielectric Flanges and Flange Kits:
    - a. Advance Products & Systems
    - b. Calpico, Inc.
    - c. FMC Technologies
    - d. Pipeline Seal & Insulator, Inc.
    - e. Tampa Rubber and Gasket Co., inc.
    - f. Watts Industries Inc.; Water Products Div.
    - g. Zurn Industries, Inc.; Wilkins Div.
  - 5. Strainers – 2" and smaller:
    - a. Apollo
    - b. Hammond
    - c. Milwaukee
    - d. NIBCO
  - 6. Wall Pipes
    - a. Josam Mfg. Co.
    - b. Smith (Jay R) Mfg. Co.
    - c. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
    - d. Watts Industries, Inc.
    - e. Zurn Industries, Inc.; Hydromechanics Div.

### **2.2 PIPE AND FITTINGS**

- A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.3 JOINING MATERIALS**

- A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.
- B. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
- C. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.
- D. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

## 2.4 PIPING SPECIALTIES

- A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated and of depth adequate to conceal protruding piping. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
- B. Unions:
  - 1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
  - 2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.
- C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.
- D. Dielectric Waterway Fittings: Electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.
- E. Dielectric Flanges and Flange Kits:
  - 1. Full faced gasket with same outside diameter and bolt hole arrangement as the flange. Pressure rating of 200psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.
  - 2. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.
  - 3. Lead free cast bronze meeting ASTM B584, class 125 solder type or cast iron class 125 threaded type for low pressure service and bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.
- F. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens for 4" and smaller shall be Type 304 stainless steel mesh with 0.062" perforations.
  - 1. For low pressure applications, cast iron strainers shall have 125 psi working pressure rating and cast bronze strainers shall have 150 psi working pressure rating
  - 2. Solder Ends, 2" and Smaller: Lead free cast bronze body meeting ASTM B584, screwed screen retainer with centered blowdown fitted with pipe plug.
- G. Sleeves:
  - 1. Sleeve: Refer to Division 22 Section "Common Work Results for Plumbing" for sleeve materials.

## 2.5 WALL PIPES

- A. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

## 2.6 WALL SLEEVES

- 1. Steel sleeve of schedule 40 pipe meeting ASTM A53B with 2" wide metal plate meeting ASTM A36 welded all around. Hot dip galvanized inside and out.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION, GENERAL

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

### 3.2 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

### 3.3 INSTALLATIONS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
- C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- I. Verify final equipment locations for roughing in.

### 3.4 PIPING PROTECTION

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

### 3.5 PENETRATIONS

- A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.
- B. Provide escutcheons for exposed pipe penetrations of interior floors, walls, ceilings and under cabinets and millwork. Use deep pattern escutcheons where required.
- C. Above Grade Concrete or Masonry Penetrations
  - 1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
    - a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
    - b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
    - c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:
      - 1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).
      - 2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).
    - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

D. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum ½" annular space between pipe and wall pipe.
2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
3. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."
5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

E. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.

F. Concrete Slab on Grade Penetrations:

1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.
2. Provide ½" thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2" above and below the concrete slab.

G. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

H. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.

### 3.6 FITTINGS AND SPECIALTIES

- A. Use fittings for all changes in direction and all branch connections.
- B. Remake leaking joints using new materials.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, mixing valve, backflow preventer and elsewhere as indicated.
- E. Install unions at the final connection to each piece of equipment adjacent to each isolation valve or valve assembly for connections 2" and smaller. Install unions where indicated elsewhere on the drawings.
- F. Install dielectric unions for piping 2" and smaller to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.
- G. Install dielectric waterway fittings for piping 2" and smaller for copper or brass pipe connections to carbon steel equipment connections.
- H. Dielectric Flange Installation:

1. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.
2. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.
3. Provide full face gasket with pressure rating equal to system served.
4. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

### 3.7 JOINTS

#### A. Non-ferrous Pipe Joints:

1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.
2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

#### B. Joints for other piping materials are specified within the respective piping system Sections.

### 3.8 PIPE FIELD QUALITY CONTROL

#### A. Testing: Refer to individual piping system specification sections.

#### B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

**END OF SECTION 220515**

PLUMBING & PLUMBING PIPING SYSTEMS  
INSPECTION REPORT FORM

Project Name: \_\_\_\_\_  
Project No: \_\_\_\_\_ Contractor Project No. \_\_\_\_\_  
General Contractor: \_\_\_\_\_  
Inspection Date: \_\_\_\_\_ Temperature: \_\_\_\_\_

System Inspected

Building: \_\_\_\_\_  
Location/Description: \_\_\_\_\_  
Service: \_\_\_\_\_

Inspection Results

Time of Inspection: \_\_\_\_\_  
Approval to Insulate:        Y    N                      Approval to Cover in Wall: Y    N  
Approval to backfill        Y    N

Signatures

Witness: \_\_\_\_\_ Representing: \_\_\_\_\_  
Witness: \_\_\_\_\_ Representing: \_\_\_\_\_  
Witness: \_\_\_\_\_ Representing: \_\_\_\_\_

Remarks

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Contractor Supervisor's signature: \_\_\_\_\_

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## **SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section includes general duty valves common to most plumbing water distribution piping systems.
  - 1. Special purpose valves are specified in individual piping system specifications.
- B. Contractors Option:
  - 1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined plumbing piping systems to connect plumbing piping where used shall be provided in compliance with specification Section 221111 "Mechanically Joined Plumbing Piping Systems".

#### **1.2 DEFINITIONS**

- A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content  $\leq 0.25\%$  per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

#### **1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
  - 1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.
- B. Submit certification that valves for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

#### **1.4 QUALITY ASSURANCE**

- A. Single Source Responsibility: Provide products specified in this section from the same manufacturer where products are available and conform to the specification requirements.
- B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the MSS Standard Practices below:
  - 1. MSS SP 71 "Gray Iron Swing Check Valves, Flanged and Threaded Ends"
  - 2. MSS SP 72 "Ball Valves with Flanged or Butt Welding Ends"
  - 3. MSS SP 80 "Bronze Gate, Globe, Angle and Check Valves"
  - 4. MSS SP 85 "Gray Iron Globe and Angle Valves, Flanged and Threaded Ends"
  - 5. MSS SP 110 "Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends"
  - 6. MSS SP 125 "Check Valves: Gray Iron and Ductile Iron, In-Line, Spring Loaded, Center-Guided"
  - 7. MSS SP 139 "Copper Alloy Gate, Globe, Angle and Check Valves for Low Pressure/Low Temperature Plumbing Applications"
- D. Valves shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.
- E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves containing no more than 0.25% lead by weight compliance for valves for domestic water distribution.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 MANUFACTURERS**

- A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed in valve schedule.

### **2.2 VALVE FEATURES, GENERAL**

- A. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
- B. Sizes: Same size as upstream pipe, unless otherwise indicated.
- C. Operators: Provide the following special operator features:
  - 1. Handwheels, fastened to valve stem, for valves other than quarter turn.
  - 2. Lever handles, on quarter-turn valves 6-inch and smaller.
- D. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- E. End Connections: As indicated in the valve specifications.
  - 1. Threads: Comply with ANSI B1.20.1.
  - 2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
  - 3. Solder-Joint: Comply with ANSI B16.18.
    - a. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

### **2.3 BALL VALVES**

- A. Ball Valves, 2 Inch and Smaller: Meeting MSS SP 110, Class150, 600-psi CWP; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof stem and chrome-plated lead free brass ball, with replaceable "Teflon" or "TFE" seats and seals, solder ends and vinyl-covered steel handle.

### **2.4 CHECK VALVES**

- A. Swing Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body and cap of ASTM B 584 cast lead free bronze; with horizontal swing, Y-pattern, disc and disc holder of ASTM B 283 alloy C46400 naval brass; solder ends. Provide valves capable of being reground while the valve remains in the line.
- B. Lift Check Valves, 2-Inch and Smaller: Meeting MSS SP-139; 250-psi CWP, body, disc holder and cap of ASTM B 584 cast lead free bronze; horizontal or angle pattern, lift-type valve, with stainless steel spring, renewable "Teflon" disc and solder ends. Provide valves capable of being refitted and ground while the valve remains in the line.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATIONS**

- A. Install valves in accordance with manufacturer's installation instructions.
- B. Locate valves for easy access and provide separate support where necessary. Provide access doors and fire rated access doors as required.
- C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- D. Install valves in horizontal piping with stem at or above the center of the pipe.
- E. Install valves in a position to allow full stem movement.
- F. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.
2. Lift Check Valve: With stem upright and plumb.

### 3.2 VALVE ENDS SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
  1. Copper Tube Size, 2-Inch and Smaller: Solder ends.

### 3.3 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

- A. Domestic Hot and Cold Water Service

<u>VALVE TYPE</u>	<u>2" AND SMALLER</u>
Ball	150
Check	125

### 3.4 VALVE SCHEDULE

- A. Ball Valves (full port) – 2 inch and smaller:

<u>MANUFACTURER</u>	<u>SOLDER ENDS</u>	<u>THREADED ENDS</u>
Apollo (Conbraco)	77C-LF-200	77C-LF-100
Hammond	UP8311A	UP8301A
Milwaukee	UPBA-450	UPBA-400
NIBCO	S-585-80-LF	T-585-80-LF

- B. Swing Check Valves – 2 inch and smaller:

<u>MANUFACTURER</u>	<u>SOLDER ENDS</u>	<u>THREADED ENDS</u>
Apollo	161S-LF	161T-LF
Milwaukee	UP1509	UP509
NIBCO	S-413-Y-LF	T-413-Y-LF

- C. Lift Check Valves – 2 inch and smaller:

<u>MANUFACTURER</u>	<u>SOLDER ENDS</u>	<u>THREADED ENDS</u>
Hammond	UP947	UP943
Milwaukee	UP1548T	UP548T
NIBCO	S-480-Y-LF	T-480-Y-LF

### 3.5 APPLICATION SCHEDULE

- A. General Application: Use ball valves for shutoff duty. Refer to piping system Specification Sections for specific valve applications and arrangements.
- B. Domestic Water Systems: Use the following valve types:
  1. Ball Valves, 2" and Smaller: Class 150, 600-psi CWP, with stem extension if installed in insulated pipe.
  2. Swing Check, 2-1/2" and smaller: Class 125, cast bronze, with rubber seat.
  3. Check Valves, 2-1/2" and larger: Class 125, swing or wafer type as indicated.

### 3.6 FIELD QUALITY CONTROL

- A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

### 3.7 ADJUSTING AND CLEANING

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

**END OF SECTION 220523**

## **SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Support and attachment components.
- B. Horizontal-piping hangers and supports.
- C. Shields
- D. Vertical piping clamps
- E. Anchors and fasteners.
- F. Miscellaneous materials.
- G. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 22 Section "Plumbing Insulation", for high density insulation for protecting insulation vapor barrier and materials and methods for piping hanger installations.
  - 2. Division 22 "Water Distribution Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical domestic water distribution and heat traced piping of sizes and materials indicated.
  - 3. Division 22 "Sanitary Drainage & Vent Piping and Specialties", for pipe hanger types and spacing for heat traced and cold sanitary piping of sizes and materials indicated.

#### **1.2 ADMINISTRATIVE REQUIREMENTS**

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

#### **1.3 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.
- B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.
- C. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."
- D. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.
  - 1. Application of protective inserts and shields at pipe hangers for each type of insulation and hanger.
- E. Installer's Qualifications: Include evidence of compliance with specified requirements.

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

#### 1.4 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Field-Welding:
  - 1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
  - 2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
  - 3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."
- D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

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

#### 1.6 DEFINITIONS

- A. Terminology used in this Section is defined in MSS SP-90.

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
  - 1. Comply with MSS SP-58.
  - 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
  - 3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  - 6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.
    - b. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
    - c. Natatorium or other treated pool environments: Type 316 stainless steel.
    - d. Outdoor Locations: Galvanized steel or type 304 stainless steel.
    - e. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
    - f. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - g. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
    - h. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.
- B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:
  - a. Cooper B-Line.
  - b. Ferguson Enterprises/FNW.
  - c. PHD Manufacturing.
  - d. Thomas & Betts Corporation.
  - e. Unistrut, a brand of Atkore International Inc.
  - f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.
4. Channel Material:
  - a. Indoor Dry Locations: Galvanized steel or zinc-plated steel.
  - b. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
  - c. Outdoor Locations: Galvanized steel or type 304 stainless steel.
  - d. Natatorium or other treated pool environments: Type 316 stainless steel.
  - e. All nuts, brackets, and clamps shall have the same finish as the channel.
5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.
6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.
7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Material:
  - a. Indoor Dry Locations: Zinc-plated steel.
  - b. Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or type 304 stainless steel.
  - c. Natatorium or other treated pool environments: Type 316 stainless steel.
2. Threaded both ends or continuously threaded.
3. Minimum Size: Reference piping specification sections for rod thicknesses.
4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

D. Wire Rope Pipe Hanging Systems:

1. Manufacturers:
  - a. ASC Engineered Solutions.
  - b. Gripple.
2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
4. Cast-in-place Concrete Insert: Pressed steel body with sintered steel wedge, 302 stainless steel spring and UV stabilized homopolymer polypropylene end cap. Model: Gripple Spider Hanging Kit.
5. Cable Stud: Carbon steel, zinc-coated, designed for attachment to concrete inserts. Model: ASC Engineered SolutionsC120.
6. Cable Coupling: Carbon steel, zinc-coated, designed for attachment to threaded rods. Model: ASC Engineered SolutionsC130.
7. Cable Eyelet: Carbon steel, zinc-coated, designed to be directly attached to structural supports via anchors or fasteners. Model: ASC Engineered SolutionsC150.
8. Cable Toggle: Carbon steel, zinc-coated, with toggle designed for insertion into 1/2 inch hole through steel deck hat channel and provides anchor when pulled in tension. Model: ASC Engineered SolutionsC160.
9. Swivel Toggle Insert: Single assembly attached to wire rope cable, manufactured from plated carbon steel toggle, pins, and shackles; swivel insert engineered to be compatible with concrete insert.
10. Wire Rope: High tensile steel wire rope, to ASTM A1023, Class A zinc coating; minimum 7 by 7 cross-sectional thread construction; having a tensile strength of 256,000 psi; No.3 wire size minimum.
11. Adjustable Fastener: Mild steel (type UG2), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 500 lb. Model: Gripple No. 2, 3 or 4 UniGrip.

## 2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. MANUFACTURERS

1. ASC Engineered Solutions.

2. Cooper B-Line, Inc.
  3. Elite Components
  4. ERICO/Michigan Hanger Co./Caddy
  5. Ferguson/FNW.
  6. Halfen-DEHA.
  7. Hilti.
  8. National Pipe Hanger Corporation.
  9. PHD Manufacturing.
  10. Power-Strut.
  11. Unistrut.
- B. Single Hangers:
1. Split Ring: Carbon steel, adjustable swivel, split ring type.
  2. Split Ring 2 inch and smaller: Copper alloy, split ring type.
  3. Clevis Hanger: Carbon steel, adjustable, clevis type.
  4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.
- C. Trapeze and Strut-mounted Supports:
1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
  2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.
- D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:
1. Manufacturers:
    - a. ASC Engineered Solutions.
    - b. Holdrite.
    - c. Klo-Shure.
  2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.
- E. Spring Hangers:
1. Reference Section "Vibration Isolation for Plumbing Piping and Equipment" for spring isolation hangers.
- F. Wall Supports:
1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.
  2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.
- G. Floor Supports:
1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- H. Pre-Insulated Supports:
1. Manufacturers:
    - a. Aeroflex USA, Inc.
    - b. ASC Engineered Solutions
    - c. Armacell.
    - d. Buckaroos, Inc.
    - e. Cooper B-Line, Inc.
    - f. Pipe Shields, Inc.
  2. General Construction and Requirements:
    - a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.
    - b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
    - c. Waterproof calcium silicate insulation shall conform to ASTM C795.
    - d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.
    - e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.



3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

## 2.3 SHIELDS

### A. Insulation Protection Shield:

1. Sheet metal construction, meeting SP-58 Type 40, of 18 gauge for 5-1/2" inside dimension and smaller, 16 gauge for 6-1/2" to 10-3/4" inside dimension 14 gauge for 11-3/4" to 17" inside dimension, and 12 gauge for 18" to 28" inside dimension.
2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
4. For pipes 2 inch and smaller using fiberglass or flexible elastomeric insulation without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in)					
		Hanger Spacing, (ft)					
		5	6	7	8	9	10
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
≤ 2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

- B. 360° Insulation Protection Shield: Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Plastic Shields:
  1. Manufacturers:
    - a. Armacell.
    - b. Eaton.
    - c. Hydra-Zorb.
    - d. PHD Manufacturing.
    - e. Zsi Foster.
  2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

## 2.4 VERTICAL-PIPING SUPPORTS

### A. Manufacturers:

1. ASC Engineered Solutions.
2. Cooper B-Line, Inc.
3. Halfen-DEHA.
4. Hilti.
5. ERICO/Michigan Hanger Co.
6. National Pipe Hanger Corporation.
7. PHD Manufacturing.
8. Power-Strut.
9. Unistrut.

### B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.
2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.
- C. Riser Clamps with pre-manufactured polymer insert:
1. Manufacturers:
    - a. Hydra-Zorb; Titan Riser Clamp.
    - b. National Pipe Hanger.
    - c. Pipe Hangers, Inc.
- D. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

## 2.5 ANCHORS AND FASTENERS

- A. Manufacturers:
1. Hilti, Inc.
  2. Illinois Tool Works, Inc.
  3. Phillips.
  4. Powers Fasteners, Inc.
  5. Rawl.
  6. Simpson Strong-Tie Company Inc.
- B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
1. Concrete: Use preset concrete inserts or expansion anchors.
  2. Solid or Grout-Filled Masonry: Use expansion anchors.
  3. Hollow Masonry: Use toggle bolts.
  4. Hollow Stud Walls: Use toggle bolts.
  5. Steel: Use beam clamps.
  6. Sheet Metal: Use sheet metal screws.
  7. Wood: Use wood screws.
  8. Plastic and lead anchors are not permitted.
  9. Hammer-driven anchors and fasteners are permitted only as follows:
    - a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
    - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.
- E. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
1. Comply with MFMA-4.
  2. Channel Material: Use galvanized steel.
  3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
  4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rod dimensions.
  5. Manufacturers:
    - a. Same as manufacturer of metal channel (strut) framing system.
    - b. DeWalt "Bang-It" concrete inserts.
- F. Post-Installed Concrete and Masonry Expansion Anchors:
1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
  2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.
- G. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.
1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
  2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- H. Vibration Isolation Anchors: Reference Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for vibration isolation anchors.

## 2.6 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Malleable Iron: ASTM A47
- I. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

## **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, GENERAL

- A. Install hangers and supports in accordance with manufacturer's installation instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

### 3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.
- B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- C. Space attachments within maximum piping span length specified in Division 22 piping sections.
- D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- E. Install hangers, supports, clamps and attachments to support piping properly from building structure.
- F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.
- G. Hanger and clamps sizing:
  - 1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
  - 2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.

3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
  4. Refer to Division 22 Section "Plumbing Insulation" for definition of hot and cold piping and required insulation thickness.
- H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 22 piping sections.
1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
  2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
    - a. Uninsulated Copper Pipe: Install with plastic galvanic isolators
    - b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".
- I. Install building attachments within concrete or to structural steel.
1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 22 piping sections.
  2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.
- K. Install appropriate types of hangers and supports to allow controlled 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.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
1. Riser Clamps: Attach riser clamps to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section "Plumbing Insulation".
    - a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert for cold piping 2-1/2 inches and larger.
  2. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section "Plumbing Insulation". Do not use polymer-based shields for hot piping.
    - a. Exception for horizontal cold-piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.
  3. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.
  4. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
- O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
  2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".
- P. Vertical Piping Risers:
1. Reference Section "Vibration Isolation for Plumbing Piping and Equipment" for piping riser supports.
- Q. Wire Rope Hanging Systems:

1. Install in accordance with manufacturer's instructions.
2. Supported load shall not exceed manufacturer's recommended load rating.
3. Applications for Pipe Supports:
  - a. 3 inch and smaller.
  - b. Wire rope hanging system is not allowed for steam or steam condensate piping.
4. Do not support pipe by wrapping the rope around the pipe.
5. Provide appropriate hanger or support compatible with the wire rope hanging system adjustable fastener as specified in Division 22 piping sections.
6. Install cast-in-place concrete inserts in elevated concrete slabs.
7. Install bream clamps for attachment to structural beams as required.

R. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.

S. Pre-Engineered Roof Pipe Supports: Set supports on an 18" X 18" x 3/16" thick roof walkway material compatible with the roof material.

### 3.4 EQUIPMENT SUPPORTS

- A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
- B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.
- C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
- D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
  1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.
- F. Secure fasteners according to manufacturer's recommended torque settings.
- G. Remove temporary supports.
- H. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- I. Grouting: Place grout under supports for piping and equipment.

### 3.5 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- 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 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

### 3.6 FIELD QUALITY CONTROL

- A. Examine support and attachment components for damage and defects.

- B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."
  - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.
- F. Correct deficiencies and replace damaged or defective support and attachment components.

### 3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:
- C. Single Hangers:
  - 1. All pipe sizes 1-1/2 inch and less:
    - a. Band hanger.
    - b. Swivel split ring.
    - c. Clevis hanger.
  - 2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.
  - 3. All drainage pipe sizes: Clevis hanger.
- D. Trapezes and Strut-mounted Supports:
  - 1. All pipe sizes less than 6 inches: Two-piece clamp.
- E. Wall Supports:
  - 1. Pipe sizes 3 inches and less:
    - a. Two-hole strap mounted to wall.
    - b. Welded steel bracket with reinforced angle or strut.
- F. Floor Supports:
  - 1. Pipe sizes 4 inch and less: Pipe saddle.

**END OF SECTION 220529**

## **SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.
- B. Types of identification devices specified in this Section include the following:
  - 1. Plastic Pipe Markers
  - 2. Plastic Tape
  - 3. Underground-Type Plastic Line Marker
  - 4. Valve Tags
  - 5. Valve Schedule Frames
  - 6. Engraved Plastic-Laminate Signs
  - 7. Plastic Equipment Markers
  - 8. Plasticized Tags

#### **1.2 CODES AND STANDARDS:**

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

#### **1.3 SUBMITTALS**

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
- C. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section "General Plumbing Requirements."

### **PART 2 - PRODUCTS AND MATERIALS**

#### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:
  - 1. Advanced Graphic Engraving, LLC.
  - 2. Brady Co.
  - 3. Brimar Industries, Inc.
  - 4. Craftmark.
  - 5. Kolbi Pipe Marker Co.
  - 6. Seton

#### **2.2 PLUMBING IDENTIFICATION MATERIALS**

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

## 2.3 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1
- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
  - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
  - 2. Adhesive lap joint in pipe marker overlap.
  - 3. Laminated or bonded application of pipe marker to pipe (or insulation).
  - 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".
- E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
- F. Lettering: Comply with piping system nomenclature as specified, scheduled, or shown, and abbreviate only as necessary for each application length.

## 2.4 PLASTIC TAPE

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

## 2.5 UNDERGROUND-TYPE PLASTIC LINE MARKER

- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of buried pipe.
  - 1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

## 2.6 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
  - 1. Provide 1-1/2" diameter tags, except as otherwise indicated.
  - 2. Fill tag engraving with black enamel.
- B. Plastic Laminate Valve Tags: Provide manufacturer's standard 3/32" thick engraved plastic laminate valve tags, with piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
  - 1. Provide 1-1/2" sq. black tags with white lettering, except as otherwise indicated.
- C. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16" high letters and sequenced valve numbers approximately 3/8" high, and with 5/32" hole for fastener.
  - 1. Provide 1-1/8" sq. white tags with black lettering.



- D. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

## 2.7 CEILING TACKS

- A. Description: Steel with 3/4" diameter color coded head.
- B. Color:
  - 1. Comply with ANSI A13.1, except where another color selection is indicated.

## 2.8 ACCESS PANEL MARKERS

- A. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

## 2.9 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

## 2.10 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with ASTM D 709, in the sizes and thickness indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for plumbing fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

## 2.11 PLASTIC EQUIPMENT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:
  - 1. Green: Cooling equipment and components.
  - 2. Yellow: Heating equipment and components.
  - 3. Yellow/Green: Combination cooling and heating equipment and components.
- B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
  - 1. Name and plan number.
  - 2. Equipment service.
  - 3. Design capacity.
  - 4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
- C. Size: Provide 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

## 2.12 PLASTICIZED TAGS

- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing. Tags shall be minimum 3-1/4" x 5-5/8" in size, provided with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

## 2.13 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or,

if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

### **PART 3 - EXECUTION**

#### **3.1 GENERAL INSTALLATION REQUIREMENTS**

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

#### **3.2 PIPING SYSTEM IDENTIFICATION**

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
  1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Application: Provide piping system identification for the following systems:
  1. Domestic cold water piping.
  2. Domestic hot water piping.
  3. Domestic hot water recirculating piping.
  4. Sanitary and waste piping.
  5. Vent piping.
- C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
  1. Within 5 feet of each valve and control device.
  2. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.
  3. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.
  4. At access doors, manholes and similar access points which permit view of concealed piping.
  5. Within 5 feet of major equipment items and other points of origination and termination.
  6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

#### **3.3 UNDERGROUND PIPING IDENTIFICATION**

- A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

#### **3.4 VALVE IDENTIFICATION**

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units.
- B. List each tagged valve in valve schedule for each piping system. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.
  1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

### 3.5 CEILING TACK INSTALLATION

- C. Install ceiling tacks to locate valves above lay-in panel ceilings. Locate in corner of panel closest to equipment.

### 3.6 PLUMBING EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
  - 1. Main control and operating valves.
- B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.
- D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
  - 1. Optional Use of Plasticized Tags: At Installer's option, where equipment to be identified is concealed above acoustical ceilings or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).
  - 2. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.

### END OF SECTION 220553

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## **SECTION 220700 - PLUMBING INSULATION**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SECTION INCLUDES**

- A. Piping Insulation.
- B. Equipment Insulation.

#### **1.2 RELATED REQUIREMENTS**

- A. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields and high-density insulation inserts.

#### **1.3 DEFINITIONS**

- A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.
- B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.
- C. Exposed: Insulation that is visible from the occupied space.
- D. NAIMA: North American Insulation Manufacturers Association

#### **1.4 SUBMITTALS**

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of Plumbing insulation.
- B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of Plumbing insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

#### **1.5 QUALITY ASSURANCE**

- A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Flame/Smoke Ratings: Provide composite plumbing insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
  - 1. Exception: Exterior plumbing insulation may have flame spread index of 75 and smoke developed index of 150.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

## 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 PIPING INSULATION MATERIALS

- A. Mineral Fiber (rock, slag, or glass):
  - 1. Manufacturers:
    - a. Knauf Insulation
    - b. Johns Manville
    - c. Owens Corning
  - 2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.
    - a. K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.
    - b. Minimum Service Temperature: 0 degrees F
    - c. Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.
    - d. Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.
  - 3. Factory Applied Jacket: ASTM C1136, Type I.
    - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.
    - b. Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.
    - c. Color: White.
- B. Flexible Elastomeric:
  - 1. Manufacturers:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. K-Flex USA.
  - 2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.
    - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
    - b. Minimum Service Temperature: Minus 297 degrees F
    - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
  - 3. Factory Applied Jacket:
    - a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Jacket requirements in Part 3 of this specification for application of this jacket.
- C. Field-Applied Jacket:
  - 1. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
    - a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
    - b. Manufacturers:
      - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
      - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
      - 3) Or approved equal.
  - 2. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in) Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco

    - a. Banding:
      - 1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
      - 2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
  - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
  - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
- D. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
  1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
  2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.
  3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
  4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
  5. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.
- F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
  - G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.
  - H. High Density Insulation Billets:
    1. Calcium Silicate: ASTM C533 and C795.
  - I. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW.
    - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
    - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
  - J. Pipe Insulation Accessories: Provide staples, Bands, Wires, and Cement and other appurtenances as recommended by insulation manufacturer for applications indicated.
  - K. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
  - L. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.
  - M. High Density Insulation Billets:
    1. Cellular Glass: ASTM C552.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

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

### 3.2 PROTECTION AND REPLACEMENT

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.
- B. Repair existing plumbing insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.
- C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

### 3.3 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

### 3.4 PLUMBING PIPING SYSTEM INSULATION

- A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Exposed Piping: Locate insulation and cover seams in least visible locations.
- E. Cold Piping Insulation:
  - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
  - 2. Provide with factory applied vapor barrier jacket.
  - 3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
  - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
  - 5. Secure all-service jacket with self-sealing longitudinal laps.
- F. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture infiltration.
- G. Hot Piping Insulation:
  - 1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
  - 2. Provide jackets without vapor barrier. Jackets with factory applied vapor barrier are allowed.
  - 3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
  - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
  - 5. Secure all-service jacket with self-sealing longitudinal laps.
  - 6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.



### 3.5 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.
- C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- E. Clean and dry pipe surfaces prior to insulating.
- F. Cold Pipe Insulation:
  - 1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
  - 2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports.
  - 3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section "Hangers and Supports for Plumbing Piping" for insulation shields.
  - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
  - 5. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.
- G. Hot Pipe Insulation:
  - 1. Provide pipe hangers for hot piping sized for the outside diameter of piping.
  - 2. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints. Seal exposed insulation at hanger with joint sealant.
- H. Pipe insulation:
  - 1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
  - 2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports.
  - 3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section "Hangers and Supports for Plumbing Piping" for insulation shields.
  - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
  - 5. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints.
  - 6. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints.
  - 7. For cold pipes, apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.
- I. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves (except check valves and flow control valves), strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Butt tightly against adjoining pieces and bond with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with

- insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves (except balancing and flow control valves), flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- J. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- K. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
- L. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

### 3.6 EXISTING INSULATION REPAIR]

- A. [Repair damaged sections of existing Plumbing insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

### 3.7 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

### 3.8 PIPING SYSTEM INSULATION SCHEDULE

- A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.
- B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.
- C. Omit insulation on the following:
1. Chrome-plated exposed piping
  2. Water Hammer Arrestors
  3. Flow control valves
  4. Drain lines from water coolers

5. Buried piping
6. Check valves.

D. Cold Piping (minimum operating temperature less than 60 degrees F.)

1. Service
  - a. Potable cold water piping.
  - b. Potable chilled water piping.
  - c. Plumbing vents within 6 lineal feet of roof outlet.
  - d. Condensate piping inside the building.
2. Insulate each piping system specified above with one of the following types of insulation.
  - a. Mineral fiber.

E. Hot Temperature Piping (105 degrees to 180 degrees F (40 to 82 degrees C)):

1. Service:
  - a. Hot water supply and return piping.
2. Insulate each piping system specified above with one of the following types of insulation.
  - a. Mineral fiber.

### 3.9 PIPE INSULATION THICKNESS SCHEDULE

A. P-traps:

1. Insulate P-traps receiving chilled water waste and P-traps of water coolers as described below:
  - a. Flexible Elastomeric: 1" thick for pipe sizes up to and including 2", 1-1/2" thick for pipe sizes 2" to 6" (largest size permitted).

B. Piping Inside Masonry Wall Units:

1. Insulate cold, hot, and hot water recirculation piping installed inside of masonry walls where the piping needs to be insulated as the wall is constructed as described below:
  - a. Flexible Elastomeric: 1/2" thick for pipe sizes up to and including 2", 1" thick for pipe sizes 2-1/2" to 6" (largest size permitted).

C. IECC – 2012 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness						
	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./hr·ft²·°F	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
	Insulation Thickness, in.						
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0

Notes:

- a. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
- b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:  $T = r\{(1 + t/r)^{(K/k)} - 1\}$  where
  - 1) T = minimum insulation thickness (in.),
  - 2) r = actual outside radius of pipe (in.),
  - 3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
  - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
  - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
- d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

### 3.10 PIPING JACKET SCHEDULE

- A. Exposed piping within mechanical rooms (below 10 feet):
  - 1. Semi-rigid PVC.
  - 2. Rigid aluminum shell.
- B. Exposed piping within mechanical rooms (above 10 feet):
  - 1. Semi-rigid PVC.
  - 2. Rigid aluminum shell.
- C. Exposed piping:
  - 1. All-service jacket.
  - 2. Semi-rigid PVC.
- D. Piping within return air plenums:
  - 1. All-service jacket.

**END OF SECTION 220700**

## **SECTION 221100 - WATER DISTRIBUTION PIPING AND SPECIALTIES**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section includes domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties within the building to a point 5 feet outside the building.
- B. Contractors Option:
  - 1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves, and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined water distribution piping systems where used shall be provided in compliance with specification Section 221111 "Mechanically Joined Plumbing Piping Systems".
- C. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
  - 2. Division 2 Section "Water Service Systems," for water service piping beginning from 5'-0" outside the building.
  - 3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
  - 4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.
  - 5. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, dielectric unions, dielectric flanges, and mechanical sleeve seals.
  - 6. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.
  - 7. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials, and methods for hanging and supporting water distribution piping.
  - 8. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.
  - 9. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties," for material and methods for trap primer outlet piping.
- D. Products installed but not furnished under this Section include water meters that will be provided by the utility company to the site and ready for installation.

#### **1.2 DEFINITIONS**

- A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.
- B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.
- C. Pipe sizes used in this Specification are nominal pipe size (NPS).
- D. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content  $\leq 0.25\%$  per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

#### **1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
  - 1. Product data for each piping specialty and valve specified.
  - 2. Welder Certificates signed by Contractor certifying that welders comply with requirements specified in Article "Quality Assurance" below.
  - 3. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
  - 4. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
  - 5. Test reports specified in Part 3 of this Section.

6. Submit certification that specialties and fittings for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following specialties need not comply:
  - a. Emergency mixing valves
  - b. Trap primers

#### 1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following codes:
  1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
  2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.
- B. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.
- C. Pipe, fittings, and specialties shall be manufactured in the United States or be certified to meet ASTM and ANSI standards.

#### 1.5 SPARE PARTS

- A. Maintenance Stock: Furnish one valve key for each key-operated wall hydrant, hose bibb, fixture supply, or faucet installed.

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Automatic Flow Control Valves:
    - a. Calefi
    - b. Flow Design, Inc., Autoflow Div.
    - c. Victaulic Company
  2. Piston Type Water Hammer Arresters:
    - a. Amtrol, Inc.
    - b. Josam Co.
    - c. Precision Plumbing Products, Inc.
    - d. PROFLO
    - e. Sioux Chief Manufacturing Co.
    - f. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
    - g. Watts Regulator Co.
    - h. Zurn Industries, Inc. Wilkins Regulator Div.
  3. Point of Use Thermostatic Mixing Valves
    - a. Acorn Engineering Co.
    - b. Cash Acme
    - c. Leonard Valve Co.
    - d. Powers Process Controls
  4. Emergency Mixing Valves
    - a. Acorn Engineering Co.
    - b. Bradley
    - c. Haws Corp.
    - d. Leonard Valve Co.
  5. Trap Primers and Distribution Units
    - a. Mifab Manufacturing, Inc.
    - b. Precision Plumbing Products, Inc.
    - c. PROFLO
    - d. Sioux Chief
  6. Plumbing Pipe Support Brackets
    - a. Holdrite
    - b. PROFLO
    - c. Sioux Chief

- 7. Tube Suspension Clamps
  - a. PROFLO
  - b. Sioux Chief or approved Equivalent

## 2.2 PIPE AND TUBE MATERIALS, GENERAL

- A. Pipe and Tube: Refer to Part 3, Articles "Above Ground Water Distribution Pipe and Fittings" or "Below Ground Water Distribution Pipe and Fittings", for identification of systems where the materials listed below are used.
- B. Copper Tube: ASTM B88, Type L Water Tube, drawn temper.
- C. Copper Tube: ASTM B88, Type K Water Tube, annealed temper.

## 2.3 FITTINGS

- A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.
- B. Brass Fittings: Chrome plated ANSI B16, Class 125 with threaded connections.
- C. Bronze Flanges: ANSI B16.24, Class 150, raised ground face, bolt holes spot faced.

## 2.4 JOINING MATERIALS

- A. Solder Filler Metal: ASTM B32 Alloy Sb-5, 95-5 Tin-Antimony.
- B. Brazing Filler Metals: AWS A5.8, Bag-7 Silver.

## 2.5 GENERAL-DUTY VALVES

- A. General-duty valves (i.e., check and ball valves) are specified in Division 22 Section "General Duty Valves for Plumbing Piping." Special duty valves are specified below by their generic name; refer to Part 3, Article "Valve Applications" for specific uses and applications for each valve specified.

## 2.6 SPECIAL DUTY VALVES

- A. Automatic Flow Control Valves: 400 PSI WOG, flow regulator, with series 300 stainless steel body, series 300 stainless steel automatic pre-set flow balancing cartridge, union connection body, and threaded-end connections.

## 2.7 PIPING SPECIALTIES

- A. Piston Type Water Hammer Arresters: Piston type, with casing of type "L" copper tube and spun copper ends, nylon piston with two EPDM "O"rings pressure lubricated with FDA approved silicone, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.
- B. Point of Use Thermostatic Mixing Valves:
  - 1. Lead free bronze or brass body meeting ASTM B584 with non-corrosive parts, tamper resistant temperature adjustment, checks, stops, other components as scheduled and meeting ASSE 1070. Valve shall be designed to fail to the cold side of the system. Maximum pressure drop shall not be exceeded for the scheduled flow rate.
- C. Emergency Mixing Valves:
  - 1. Bronze body construction meeting ASTM B584, non-corrosive parts, tamper resistant temperature adjustment, union inlets. Valve shall be designed to fail to the cold side of the system with full cold water flow. Maximum pressure drop shall not be exceeded for the scheduled flow rate.
- D. Trap Primers: Brass construction, line pressure operation, capacity to prime number of traps as indicated with distribution units complying with requirements of ASSE Standard 1018.
- E. Pipe Support Brackets:

1. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of 1/2" on 2" centers and holes of 3/4" or 1" on 4" centers.
  2. Pipe Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent pipe in wall.
  3. Carrier Bracket: 20 gauge copper bracket with 1" hole for supporting rough-in for flush valve copper tube and bolt slot for attaching to chair carrier.
- F. Tube Suspension Clamps
1. Combination plastic supports and insulators for installing copper tube in stud walls with integral bracket for securing to stud with screws.

### **PART 3 - EXECUTION**

#### **1.1 INSTALLATION, GENERAL**

- A. Install piping, valves and specialties in accordance with manufacturer's installation instructions.

#### **3.2 PREPARATION FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS**

- A. Copper Tube: Provide 6" thick sand pipe bed underneath and around sides of pipe, up to middle half of the pipe. Support pipe in trench with sand bags level and true at fittings to prevent sand, gravel or debris from interfering with the brazing process. After pressure testing is complete, install bedding at fittings and install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

#### **3.3 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS**

- A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 8 inches and smaller, within the building.

#### **3.4 BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS**

- A. Install Type K, soft annealed copper tube and brazed joints for pipe sizes 2 inches and smaller, with minimum number of joints, inside and outside building.

#### **3.5 PIPING INSTALLATION**

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.



- I. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- J. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.
- K. Install piping level with no pitch.

### 3.6 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Pipe Attachments: Install the following:
  - 1. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
  - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs. Provide copper coated riser clamps when in contact with copper tube.
  - 3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Supports and Anchors" and "Plumbing Insulation".
  - 4. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls and for securing 1-1/4" to 2" copper tube inside walls and chases for battery fixtures. Secure clamp to the copper tube.
    - a. Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section "Plumbing Insulation" for requirement for maintenance of the vapor barrier and vapor barrier seal method.
  - 5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of stainless steel tube 2" and smaller on walls or for securing tube inside walls for connection to faucets.
  - 6. Support copper tube in chases and walls at plumbing fixtures with plastic or copper brackets secured to structure and U-bolts sized to bare on the pipe.
  - 7. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube. Provide two piece straps and 360° insulation protection shields sized for the insulation thickness used for the pipe for all insulated pipes.
  - 8. Secure copper tube rough-in for individual fixtures with sheet stud brackets attached to the wall studs or pipe mounting brackets attached to the fixture waste & vent pipe at each plumbing fixture.
  - 9. Secure 1" and smaller copper water tubing in stud walls at stud penetrations with tube suspension clamps.
    - a. Cut hole through non-supporting studs with a minimum 1/8" clearance around each uninsulated copper tube or insulated copper tube.
    - b. Seal each joint of insulation and tube suspension clamp to maintain the insulation barrier. Refer to Division 22 "Plumbing Insulation" for requirement for maintenance of the vapor barrier similar to insulation butted against insulation inserts and vapor barrier seal method.
  - 10. Secure copper tubes for flush valve wall mounted water closets to the chair carrier with carrier brackets.
  - 11. Provide roll hangers for individual horizontal runs 100 feet or longer.
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

<u>Nom. Pipe Size - In.</u>	<u>Copper Tube Max. Span - Ft.</u>	<u>Min. Rod Dia. - In.</u>
Up to 1-1/4	6	3/8
1-1/2 to 2	10	3/8
2-1/2 to 4	10	3/8

- 1. Support vertical copper tube at each floor and in intervals not to exceed 10 feet.

- D. Support water piping within 12" of each elbow or tee and for water piping 2-1/2" and larger at each valve or strainer.
- E. Support water piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

### 3.7 PIPE AND TUBE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
  - 1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.
  - 2. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
  - 3. Heat joints to proper and uniform temperature.
- C. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:
  - 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
  - 2. Align threads at point of assembly.
  - 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
  - 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
    - a. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- D. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Provide dielectric waterway fittings for 2" and smaller in concealed locations. Dielectric unions, waterway fittings and flanges are specified in Section "Basic Piping Materials and Methods".
- E. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

### 3.8 VALVE APPLICATIONS

- A. General-Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Shut-off duty: Use ball valves.

### 3.9 INSTALLATION OF VALVES

- A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inches and smaller, use ball valves.
- B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, on each supply to each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inches and smaller, use ball valves.
- C. Drain Valves: Install drain valves on each plumbing equipment item, located to drain equipment completely for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For drain valves 2 inches and smaller, use ball valves.
- D. Check Valves: Install swing check valves on discharge side of each pump and elsewhere as indicated.
- E. Emergency Mixing Valves: Install where indicated on the plans with hot and cold water branch lines connecting to the mains without any shutoff valves. No other fixtures shall connect to the branch lines feeding the emergency mixing valve. Install ball valves with locking handles at the emergency mixing valve as indicated on the plans.

- F. Point-of-Use Thermostatic Mixing Valve: Install valve complying with ASSE 1070 on all public lavatories and handwashing sink locations. Install valve to be accessible by maintenance staff. Set temperature limit to 110F for dual temperature faucet or 100F for single temperature faucet.”

### 3.10 INSTALLATION OF FLOW CONTROL VALVES

- A. Install automatic flow control valves in each hot water recirculating loop, and elsewhere as indicated. Install a shutoff valve and strainer upstream and a union, check valve and shutoff valve downstream of each flow control or automatic flow control valve.
- B. Reports: Prepare hot water return system balancing reports signed and submit to the Architect upon completion of the project. Include the following information:
  - a. Valve tag number and description of location
  - b. Valve body size
  - c. Differential pressure reading from instrument in psi
  - d. Actual flow rate derived from the manufacturer's charts and tables for the valve size and measured differential pressure.

### 3.11 TRAP PRIMERS

- A. Install trap primers where indicated and where required by local authorities having jurisdiction.
- B. Connect trap primer supply line to the top of domestic cold water line no larger than 1-1/2" in diameter.
- C. Provide trap primer distribution units for trap primers serving more than one trap.
- D. Install trap primer distribution level to insure even water distribution unit to each circuit.
- E. Where applicable, adjust the trap primer for proper flow.
- F. Install trap primers a minimum of 12 inches above finished floor for every 20 feet of horizontal outlet piping to floor drains served.
- G. Install trap primers in an accessible location.
- H. Refer to Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for trap primer outlet pipe requirements.

### 3.12 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.
- B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2 inches and larger, use flanges instead of unions.

### 3.13 FIELD QUALITY CONTROL

- A. Inspections: Inspect water distribution piping as follows:
  - 1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
  - 2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
    - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.
    - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
    - c. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.

- d. Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.
- B. Piping System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
  - 1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
  - 2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
  - 3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - 4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
  - 5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

### 3.14 ADJUSTING AND CLEANING

- A. Clean and disinfect water distribution piping as follows:
  - 1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.
  - 2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not proscribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:
    - a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
    - b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.
    - c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
    - d. Following the allowed standing time, flush the system with clean, potable water until chlorine residual is lowered to incoming city water level.
    - e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.
  - 3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

### 3.15 COMMISSIONING

- A. Fill the system. Check compression tanks to determine that they are not air bound and that the system is completely full of water.
- B. Before operating the system, perform these steps:
  - 1. Open valves to full open position.
  - 2. Remove and clean strainers.

### END OF SECTION 221100

## **SECTION 221111 - MECHANICALLY JOINED PLUMBING PIPING SYSTEMS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section only applies to Mechanically Joined Plumbing Piping Systems for joining piping for Plumbing applications as defined in Division Section 22 "Water Distribution Piping and Specialties".
- B. The Division 22 contractor may provide mechanically joined, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods.
- C. Mechanically joined couplings, fittings, valves and related components specified in this section shall not be provided for natural gas piping in lieu of welded, threaded or flanged piping methods.

#### **1.2 DEFINITIONS**

- A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content  $\leq 0.25\%$  per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.
- B. CWP: Cold working pressure in psi.
- C. CTS: Copper tube size.

#### **1.3 RELATED SECTIONS INCLUDE THE FOLLOWING:**

- A. Division 22 section "Basic Plumbing Piping Materials and Methods" for materials for dielectric waterway fittings and flange kits.
- B. Division 22 Section "Water Distribution Piping and Specialties" for related sections.

#### **1.4 SUBMITTALS**

- A. Product Data: Submit data for each type of coupling, fitting and special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing.
- B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.
  - 1. If an assembly of flexible couplings are used for seismic vibration, thermal expansion, or noise and vibration reduction, submit shop drawings indicating location of assembly, including anchors and guides. Include movement analysis of the assembly, and performance data of the assembly.
- C. Maintenance Data: Include for each piping specialty and valve in Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."
- D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Failed test results and corrective action taken to achieve requirements.
- E. Submit a schedule of dissimilar metal joints and adaptor flanges and flange kits. Include joint type material, connection method and proposed flange kits to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Dielectric flange kits are specified in Division 22 section "Basic Plumbing Piping Materials and Methods".
- F. Submit certification that valves and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

- G. Submit certification that pipe, pipe fittings, pipe specialties, and valves and fittings are manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.
- H. Submit contractor certificates indicating completion of installation training course from manufacturer of piping to be used.

#### 1.5 QUALITY ASSURANCE

- A. Press to connect end product manufacturer shall be ISO certified.
- B. Obtain training from the press to connect manufacturer for all workers that will be installing or handling the press to connect piping systems.
- C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves and fittings containing no more than 0.25% lead by weight for domestic water distribution.
- D. Pipe, fittings, specialties, and valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI, and MSS standards.

#### 1.6 COORDINATION

- A. Reference Division 22 Section "Water Distribution Piping and Specialties" for coordination.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Refer to manufacturer's current literature for comparable products and pressure ratings of couplings and standard fittings for various pipe sizes and pipe schedules. Products identified by model number are based on available size ranges from that manufacturer. Products offered by manufacturers with extended ranges are acceptable provided they meet the specified requirements.
- B. Press to Connect Copper Tubing System
  - 1. Apollo "Xpress"
  - 2. GRINNELL Mechanical Products "G-Press"
  - 3. Mueller Streamline PRS
  - 4. NIBCO Inc., Press System.
  - 5. Viega ProPress

#### 2.2 PRESS TO CONNECT COPPER TUBING SYSTEM

- A. Copper Tube:
  - 1. CTS ½inch through 4inch: ASTM B-88 Type K or L.
- B. General requirements for couplings, adapters, and standard fittings:
  - 1. Acceptable body materials:
    - a. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.
    - b. Cast copper conforming to ASTM B584 alloy C87600 or C84400.
  - 2. Coupling and fitting housings with soldered ends shall conform to ASME B16.18 and B16.22.
  - 3. Coupling and fitting housings with flared ends shall conform to ASME B16.26.
  - 4. Coupling and fitting housings with threaded ends shall conform to ASME B1.20.1.
  - 5. Coupling and fitting housings for press ends shall have self-contained O-ring seals in the coupling/fitting ends.
  - 6. Rated for 200 psi CWP up to 250 degrees F maximum.
- C. O-Ring Seals: EPDM compound conforming to ASME B16.51, style suitable for the application.
- D. Flange Adapters:
  - 1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).
  - 2. 2-1/2 inch through 4 inch (ANSI class 125/150):

- a. Steel flange with NSF 14 compliant fused epoxy coating, copper or brass press to connect joint with copper face ring and plastic or rubber dielectric isolating ring separating the flange from the press to connect joint.
  3. Rated for 200 psi CWP up to 250 degrees F maximum.
- E. Valves:
  1. Provide 2 inch and smaller press to connect valves listed in this section or lead free cast bronze valves 2 inch and smaller listed in Division 22 section "Water Distribution Piping and Specialties" may be used with sweat connections or sweat X press adapters.
  2. Ball Valve:
    - a. Rated for 200 psi CWP up to 250 degrees F maximum, conforming to MSS SP-110.
    - b. Body and trim: Lead free cast bronze conforming to B584.
    - c. Ends: Female press to connect ends of copper material.
    - d. Ball: Full port, chrome-plated brass ball.
    - e. Stem: Blow-out proof, of material silicon bronze conforming to ASTM B371 or ASTM B99, or stainless steel.
    - f. Seat: PTFE or TFE, suitable for intended service.
    - g. Operator: Lever handle with non-thermal conductive material for insulated piping. Provide with 2 inch extended sleeve to allow valve operation without disturbing the insulation and with memory stop for throttling, metering or balancing service.
      - 1) Apollo # 77WLF
      - 2) NIBCO # PC-585-LF
      - 3) Milwaukee # UPBA-450-12
  3. Check Valves (Y pattern, swing type or in-line)
    - a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
    - b. Body and trim: Cast bronze conforming to ASTM B62.
    - c. Disc: PTFE renewable seat and disc.
    - d. Ends: Female press to connect ends of copper or brass material.
    - e. 2 inch and smaller:
      - 1) Apollo # 163T-PRLF
      - 2) Hammond # UP904 P2
      - 3) NIBCO # PF-413-Y-LF
      - 4) Milwaukee # UP509 P2
  4. Check Valves (lift type, in-line)
    - a. Rated for 250 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
    - b. Body: Cast bronze conforming to ASTM B584.
    - c. Spring: 316 stainless steel.
    - d. Ends: Female press to connect ends of copper or brass material.
    - e. 2 inch and smaller:
      - 1) Apollo # 61LF
      - 2) Milwaukee # UP548T P2
- F. Strainers:
  1. Provide 2 inch and smaller press to connect strainers listed in this section or lead free cast bronze strainers 2 inch and smaller listed in Division 22 section "Basic Piping Materials and Methods" may be used with sweat connections or sweat X press adapters.
  2. Strainers (Y pattern)
    - a. Rated for 250 psig CWP up to 250 degrees F maximum.
    - b. Body: Cast bronze conforming to ASTM B584.
    - c. Screen: Stainless steel mesh with 0.062" perforations.
    - d. Ends: Female press to connect ends of copper or brass material.
    - e. 2 inch and smaller:
      - 1) Apollo # 59LF

## **PART 3 - EXECUTION**

### **3.1 PIPING INSTALLATIONS**

- A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.
- B. Water distribution piping installations shall be installed subject to Division 22 Section "Water Distribution Systems and Specialties" in addition to those requirements specified in this Section.

- C. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

### 3.2 PIPE APPLICATIONS ABOVE GRADE

- A. Water piping in sizes 4 inches and smaller shall be Type L drawn copper tube with plain ends and copper tube dimensioned press to connect copper couplings and fittings.

### 3.3 HANGERS AND SUPPORTS

- A. Support of piping must account for expansion and contraction, vibration, and the dead load of the piping and its contents.
- B. General: Hanger supports, and anchors devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping." Reference Division 22 Section "Water Distribution Systems and Specialties" for pipe spacing limitations.

### 3.4 PIPE JOINT CONSTRUCTION

- A. Press to connect Copper Tubing System
  1. Ream, deburr and clean tube ends and verify they are free from indentations, projections, burrs and foreign matter.
  2. Install permanent inspection mark on tube.
  3. Clean tube and fittings of all dirt and oil. Verify O-ring is in place and free of oil, grease or dirt.
  4. Push copper tube into fittings with twisting action to all the way to the fitting stop or shoulder.
  5. Mark tube with permanent marker to indicate proper tube insertion depth.
  6. Verify press tool has correct size jaw set for tube size used.
  7. Complete one tool cycle with empty jaw to calibrate tool for each time new jaw is inserted into tool.
  8. Squeeze jaw arms to open tool jaws and place jaws around the contour of the fitting. Verify tool is perpendicular to the fitting and depress tool switch.
  9. Squeeze jaw open to remove the tool and observe witness mark.
  10. Verify crimped fitting connection for misalignment of the copper tube, misalignment of the tool or improper insertion of the tube. If any of these conditions are found cut out the joint and provide a new joint.
  11. Maintain minimum distance between joints per the manufacturer's published installation instructions.
- B. Dielectric Isolation Requirements for Press to Connect Adapter Flange Connections: Provide dielectric flanges or flange kits for the following joint types:
  1. Adapter Flanges to Iron, Ductile Iron or Steel Body Valves and Fittings (Except Butterfly Valves with EPDM Sleeve/Seats): Provide full face gaskets between flanges and adapter flanges. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on valve and adapter flanges.
  2. Adapter Flanges to Butterfly Valves with EPDM Sleeve/Seats in Series with Iron, Ductile Iron or Steel Body Valves and Fittings: At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on adapter flange. Provide steel bolts on butterfly valve flange.
  3. Adapter Flanges to Butterfly Valves in Copper Tubing: Install flat washers at each bolt on adapter flange. Provide full face gasket only for butterfly valves without integral liner acting as a gasket.
  4. Full face gaskets, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves are specified in Section "Basic Piping Materials and Methods".
- C. Flange Adapters:
  1. Install flange adapter washers when flange adapters are used against the following surfaces:
    - a. Rubber.
    - b. Adapting to ANSI/AWWA cast flanges.
    - c. Rubber faced lug valves.
    - d. Serrated flanged surfaces.

### 3.5 VALVE APPLICATIONS

- A. Reference Division 22 Section "Water Distribution Piping and Specialties" for valve applications.



### 3.6 STRAINERS

- A. Provide strainers as specified in part 2 of this specification section or Division 22 specification section "Basic Piping Materials and Methods".
  - 1. Provide manufacturer strainer with press to connect ends for 2 inches and smaller.
  - 2. Provide copper press to connect X screwed NPT adapters for 2 inches and smaller.

### 3.7 WATER DISTRIBUTION SPECIALTIES INSTALLATION

- A. Reference Division 22 Section "Water Distribution Systems and Specialties" for water distribution specialties and installation requirements.

### 3.8 FIELD QUALITY CONTROL

- A. The following procedures are paraphrased from the ASME B-31.9, code for pressure piping, building services piping.
- B. Installing contractor shall schedule training session with the press to connect manufacturer for all workers that will be installing or handling the press to connect piping systems. Submit certification letter along with list of attendees to engineer of record within 30-days of mobilization. Include copy of certification letter with closeout documents.
- C. Press to connect fitting manufacturer shall provide certification training to contractor without cost and without additional cost to Owner.
- D. Installing contractor shall visually inspect couplings and repair or replace any misaligned couplings and couplings with gaps prior to calling for inspection as defined in Division 22 Section "General Plumbing Requirements."
- E. Press to connect fitting manufacturer's representative shall make periodic visits to the jobsite during construction to ensure the installing contractor is following the latest published manufacturer's field installation instructions and best practice procedures provided during the training session.

### 3.9 STARTUP

- A. Refer to Division 22 Section "Water Distribution Piping and Specialties" for startup procedures.

### **END OF SECTION 221111**

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## **SECTION 221300 - SANITARY DRAINAGE AND VENT PIPING AND SPECIALTIES**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
  - 2. Division 33 Section "Sanitary Sewage Systems," for sanitary drainage piping beginning from 5'-0" outside the building.
  - 3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
  - 4. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.
  - 5. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
  - 6. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
  - 7. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.
  - 8. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.
  - 9. Division 22 Section "Water Distribution Piping and Specialties," for material and methods for trap primers and trap primer inlet piping.

#### **1.2 DEFINITIONS**

- A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer.
- B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

#### **1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for the following products:
  - 1. Drainage piping
  - 2. Drainage piping specialties
  - 3. Floor drains
- C. Test reports specified in Part 3 of this Section.

### **PART 2 - PRODUCTS AND MATERIALS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Drainage Piping Specialties, including cleanouts and floor drains:
    - a. Jay R. Smith Mfg. Co.
    - b. Josam Mfg. Co.

- c. Mifab Manufacturing Co.
- d. Sioux Chief Manufacturing Co. Inc.
- e. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
- f. Watts Industries, Inc.
- g. Zurn Industries, Inc.; Hydromechanics Div.
- 2. Heavy Duty Hubless Couplings
  - a. Anaco Husky HD-2000
  - b. Clamp-All 80in. lb.
  - c. Ideal Tridon "HD"
  - d. Mifab Manufacturing, Inc. #MI-XHUB-series
  - e. Mission Rubber Company, "Heavy Weight"
  - f. ProFlo "HD"
- 3. Cast Iron Soil Pipe and Fittings
  - a. AB & I Foundry
  - b. Charlotte Pipe and Foundry Company
  - c. Tyler Pipe / Soil Pipe Division
- 4. Shielded Transition Couplings
  - a. FERNCO, "Proflex 3000 Series"
  - b. Mifab Manufacturing, Inc. #MI-HUB-ARC-series
  - c. Mission Rubber Company, "Band Seal Specialty Couplings"
- 5. Underground Shielded Adapter Couplings
  - a. FERNCO, "1056 Series with SR73 Shear Ring"
  - b. Mifab Manufacturing, Inc. #MI-HUB-ARC-CL-series
  - c. Mission Rubber Company, "MR56 Series"
- 6. Trap Seals
  - a. Green Drain, Inc.
  - b. Jay R. Smith Mfg. Co.
  - c. Mifab Manufacturing, Inc.
  - d. Proset Systems "Trap Guard"
  - e. Rector Seal, Inc.
  - f. Zurn Industries, Inc.; Hydromechanics Div.
- 7. Hubless Couplings:
  - a. Anaco
  - b. Ideal Tridon
  - c. Mifab Manufacturing, Inc. #MI-HUB- series
  - d. Mission Rubber Company
  - e. ProFlo "PFNH"
  - f. Tyler Pipe / Soil Pipe Division

## 2.2 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

- A. Refer to Part 3, Article "Pipe Applications - Above Ground, Within Building" for identification of systems where the materials listed below are used.
- B. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, no-hub pipe and fittings and bearing the trademark of CISPI and NSF.
  - 1. Couplings and compression gaskets, NSF certified: ASTM C564 and CISPI 310.
  - 2. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.
- C. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.
  - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- D. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.
  - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
  - 2. Solvent: ASTM D2564.
  - 3. Fittings: Schedule 40 meeting ASTM D2466 with solvent cement socket joints.
- E. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

## 2.3 UNDERGROUND BUILDING DRAIN AND VENT PIPE AND FITTINGS

- A. Refer to Part 3, Article "Pipe Applications - Below Ground, Within Building" for identification of systems where the materials listed below are used.
- B. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
  - 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
  - 2. Solvent: ASTM D2564.
- C. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

## 2.4 DRAINAGE PIPING SPECIALTIES

- A. Cleanout Plugs: As specified on the drawings.
- B. Floor Cleanouts: As specified on the drawings.
- C. Wall Cleanouts: As specified on the drawings.
- D. Floor Drains: As specified on the drawings.
- E. Trap seals: Provide trap seals meeting either description below:
  - 1. Smooth, soft, flexible, elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom. The flow of wastewater allows duck's bill to open and adequately discharge to floor drain through its interior. The duck's bill closes and returns to original molded shape after wastewater discharge is complete. Or, smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its interior. The flapper closes and returns to original molded shape after wastewater discharge is complete.
  - 2. Smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its opening. The flapper closes and returns to original position after wastewater discharge is complete.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION, GENERAL

- A. Install pipe and specialties in accordance with manufacturer's installation instructions.

### 3.2 PREPARATION FOUNDATION FOR UNDERGROUND SANITARY BUILDING DRAINS

- A. Pipe Beds:
  - 1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

### 3.3 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

- A. Install hubless, cast-iron soil pipe and fittings for 15" and smaller soil, waste, and vent pipe.
- B. Install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings, copper sweat X screwed with solder joints, for waste connections from urinals, lavatories, sinks, water coolers, and kitchen equipment to cast iron drainage piping.

- C. Condensate drain piping and pumped condensate drain piping inside the building: Provide  $\frac{3}{4}$ " minimum size or as indicated on the drawings. Slope gravity drainage condensate piping from mechanical equipment at  $\frac{1}{8}$ " per foot minimum slope. Discharge to floor receptor with air gap.
  - 1. Install galvanized schedule 40 steel pipe and malleable iron fittings.
  - 2. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4" and larger. Provide galvanic isolators as specified in Division 22 "*Basic Piping Materials and Methods*".
  - 3. Install PVC pressure pipe and fittings for 1" and smaller and install "solid wall" PVC Type DWV pipe and fittings for 1-1/4" and larger. Except no plastic pipe shall be installed in return air plenums.
  - 4. Install CPVC CTS pipe and fittings, 2" and smaller.

#### 3.4 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

- A. Install PVC Type DWV Plastic pipe and fittings for drainage and vent pipe for 24" and smaller. Install fabricated fittings for 16 inch and larger.

#### 3.5 PIPE AND TUBE JOINT CONSTRUCTION

- A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."
- B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:
  - 1. Install hubless couplings complying with CISPI 310 on soil, waste and vent piping.
  - 2. Install hubless couplings complying with CISPI 310 on and soil and waste piping 3" and smaller and all vent piping.
  - 3. Install heavy duty hubless couplings on soil or waste stacks, soil and waste piping connections to soil or waste stacks and all soil and waste piping 4" and larger.
  - 4. Install No-Hub fitting restraints on joints 5" and larger at:
    - a. Changes of direction from vertical to horizontal
    - b. 4" branch connections, including tees, wyes and wye combination fittings to soil and waste piping 5" and larger
    - c. Horizontal changes of direction 22-1/2 degrees and greater
    - d. Changes in diameter of two pipe sizes or greater.
- C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.
- D. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.
- E. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

#### 3.6 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Paint exposed copper drain lines serving kitchen equipment with a minimum of two coats of chromium-based paint.

- H. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section " Basic Piping Material and Methods" for special sealers and materials.
- I. Foundation Penetrations: Where pipes pass through foundation walls above strip footings or under strip footings, protect pipes from building load with cast iron soil pipe sleeves two pipe sizes larger than the pipe. Sleeves installed under the strip footing shall be encased in concrete.
- J. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- K. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.
- L. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- M. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger. Install vent piping pitched to drain back by gravity to the sanitary drainage piping system.
- N. Install condensate drains pitched down at a minimum slope of 1 to 10 for piping 3 inches and smaller.

### 3.7 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
  - 1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
  - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
  - 3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".
    - a. Install high density insulation on insulated pipe.
  - 4. Provide vinyl coated hangers and riser clamps for use with PVC pipe and CPVC CTS tube.
  - 1. Provide roll hangers for individual horizontal runs 100 feet or longer.
  - 2. Provide ceiling flanges attached to the floor, all thread rod and split ring pipe clamps for indirect drains and condensate drains supported from the floor 2" and smaller.
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

<u>Nom. Pipe Size – In.</u>	<u>Steel Pipe Max. Span – Ft.</u>	<u>Copper Tube Max. Span – Ft.</u>	<u>Min. Rod Dia. - In.</u>
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 4	12	10	3/8
5	12	10	1/2
6	12	10	1/2

1. Support all sizes of horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide support at each horizontal branch.
  2. Support all sizes of vertical cast iron piping every ten feet.
  3. Support piping within 12" of each elbow or tee.
  4. Support each P-trap.
- D. Support condensate piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table above for maximum spacing of supports. Adjust pipe support to maintain minimum pipe slope.

### 3.8 INSTALLATION OF PIPING SPECIALTIES

- A. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:
1. as required by plumbing code;
  2. at each change in direction of piping greater than 45 degrees;
  3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
  4. at base of each vertical soil and waste stack.
- B. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.
- C. Floor Cleanouts: Install in below floor building drain piping as indicated, and:
1. as required by plumbing code;
  2. at each change in direction of piping greater than 45 degrees;
  3. Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping;
  4. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

### 3.9 INSTALLATION OF FLOOR DRAINS

- A. Install floor drains in locations indicated.
- B. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor. Set floor sinks and floor troughs flush with the level finish floor.
- C. Refer to architectural documents for floor slope requirements and set floor drain elevation to match.
- D. Provide P-traps for drains connected to the sanitary sewer.
- E. Install floor drains in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Position drains so that they are level, accessible and easy to maintain.

### 3.10 INSTALLATION TRAP SEALS:

- A. Install trap seals in accordance with manufacturer's written instructions and in locations indicated.
- B. Make watertight seal using an adhesive type caulk along bottom of trap seal, if required by the manufacturer.
- C. Employ a test plug for testing and remove before normal floor drain use. Clean inside of drain tailpiece and install trap seal after testing.
- D. Do not touch elastomeric plug or allow contact with primer or solvent cement.



### 3.11 CONNECTIONS

- A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

### 3.12 FIELD QUALITY CONTROL

- A. Inspections
  1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
  2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
    - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.
    - c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspection by the plumbing official.
    - d. Reports: Prepare inspection reports, signed by the plumbing official.
- B. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
  1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
  2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
  3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
  4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1" water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.
  5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
  6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

### 3.13 ADJUSTING AND CLEANING

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.

### 3.14 PROTECTION

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

### END OF SECTION 221300

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## **SECTION 224000 - PLUMBING FIXTURES**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 7 Section "Joint Sealers," for materials and methods for sealing between plumbing fixtures and interior walls.
  - 2. Division 22 Section "General Duty Valves for Plumbing Piping" for valves used as supply stops.
- C. Products furnished but not installed under this Section include:
  - 1. Plumbing fittings (including faucets) and piping indicated, for fixtures, appliances, appurtenances, and equipment provided by Owner.
  - 2. Plumbing fittings (including faucets) and piping indicated, for fixtures, appliances, appurtenances, and equipment specified in other Sections.
- D. Products installed but not furnished under this Section include:
  - 1. Owner furnished fixtures, as indicated.
  - 2. Accessories, appliances, appurtenances, and equipment specified in other Sections, requiring plumbing services or fixture-related devices, as indicated.

#### **1.2 DEFINITIONS**

- A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.
- B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.
- C. Appliance: Device or machine designed and intended to perform a specific function.
- D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.
- E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.
- F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.
- G. Fixture: Installed receptor connected to the water distribution system, that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.
- H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.
- I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:
  - 1. Carrier: Floor-mounted support for wall-mounted water closet, and support fixed to wall construction for wall-hung fixture.
  - 2. Chair Carrier: Support for wall-hung fixture, having steel pipe uprights that transfer weight to the floor.
  - 3. Chair Carrier, Heavy Duty: Support for wall-hung fixture, having rectangular steel uprights that transfer weight to the floor.
  - 4. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.

- J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.
- K. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content  $\leq 0.25\%$  per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

### 1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
  - 1. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.
  - 2. Wiring diagrams for field-installed wiring of electrically operated units.
  - 3. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
- B. Submit third party certification that faucets and trim for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following faucets and trim need not comply:
  - 1. Electronic faucets
  - 2. Flush valves

### 1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of ICC Standard A117.1, "Accessible and Usable Buildings and Facilities," and "2010 ADA Standards for Accessible Design" with respect to plumbing fixtures for individuals with disabilities.
- B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.
  - 1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of faucets and trim containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.
- D. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixtures is on the proposer.

### 1.5 SPARE PARTS

- A. Deliver spare parts to Owner. Furnish spare parts described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.
- B. Faucet Washers and O-rings: Furnish quantity of identical units not less than 10 percent of amount of each installed.
- C. Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5 percent of amount of each installed.
- D. Flushometer Repair Kits: Furnish quantity of identical units not less than 10 percent of amount of each flushometer installed.
- E. Provide individual metal boxes or a hinged-top wood or metal box having separate compartments for each type and size of above extra materials.
- F. Filter Cartridges: Furnish quantity of identical filter cartridges not less than 50 percent of amount of each type and size installed.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed for that category:
1. Water Closets:
    - a. American Standard, Inc.
    - b. Gerber Plumbing Fixture Corp.
    - c. Kohler Co.
    - d. Sloan Valve Co.
    - e. TOTO KIKI USA, Inc.
    - f. Zurn Plumbing Products Group
  2. Urinals:
    - a. American Standard, Inc.
    - b. Gerber Plumbing Fixture Corp.
    - c. Kohler Co.
    - d. Sloan Valve Co.
    - e. TOTO KIKI USA, Inc.
    - f. Zurn Plumbing Products Group
  3. Lavatories:
    - a. American Standard, Inc.
    - b. Gerber Plumbing Fixture Corp.
    - c. Kohler Co.
    - d. Sloan Valve Co.
    - e. TOTO KIKI USA, Inc.
    - f. Zurn Plumbing Products Group
  4. Sinks:
    - a. Elkay Manufacturing Co.
    - b. Franke
    - c. Just Manufacturing Co.
  5. Water Coolers:
    - a. Elkay Manufacturing Co.
    - b. Halsey Taylor; A Household International Co.
    - c. Haws Drinking Faucet Co.
  6. Wash Fountains:
    - a. Aqua Design.
    - b. Bradley Corp.
    - c. Neo-Metro
    - d. Sloan Valve Co.
    - e. Zurn
  7. Emergency Equipment:
    - a. Acorn Engineering Co.
    - b. Bradley Corp.
    - c. ENCON Safety Products
    - d. Guardian Equipment.
    - e. Haws Drinking Faucet Co.
    - f. Speakman Co.
    - g. Stingray Systems
    - h. Water Saver Faucet Co.
  8. Toilet Seats:
    - a. Bemis Mfg. Co.
    - b. Beneke Div.; Sanderson Plumbing Products, Inc.
    - c. Church Seat Co.
    - d. Kohler Co.
    - e. Olsonite Corp.
    - f. Sperzel Industries, Inc.
  9. Flushometers:
    - a. Sloan Valve Co.
    - b. Toto Kiki, USA
    - c. Zurn Industries, Inc.; Flush Valve Operations.

10. Commercial/Industrial Cast-Brass Faucets:
  - a. Chicago Faucet Co.
  - b. Delta-Commercial
  - c. Speakman Co.
  - d. T & S Brass and Bronze Works, Inc.
  - e. Zurn Industries, LTD. "Aqua Spec"
11. Sensor-Operated Faucets and Devices:
  - a. Sloan Valve Co.
  - b. [Toto Kikki, USA]
  - c. Zurn Industries, LTD. "Aqua Spec"
12. Stop Valves & Supplies:
  - a. Brass Craft Subsidiary; Masco Co.
  - b. Engineered Brass Company
  - c. McGuire Manufacturing Co., Inc.
  - d. PROFLO
  - e. Zurn Industries
13. P-traps, Drains & Miscellaneous Fittings:
  - a. Brass Craft Subsidiary; Masco Co.
  - b. Dearborn Brass
  - c. Engineered Brass Company
  - d. Franke
  - e. McGuire Manufacturing Co., Inc.
  - f. PROFLO
  - g. Watts Brass and Tubular
  - h. Zurn Industries
14. Supports:
  - a. Josam Co.
  - b. Smith (Jay R.) Mfg. Co.
  - c. Wade Div.; Tyler Pipe.
  - d. Watts Drainage Products
  - e. Zurn Industries, Inc.; Hydromechanics Div.
  - f. Mifab Manufacturing, Inc.
15. Insulation Kits
  - a. Brocar
  - b. McGuire
  - c. Plumberex
  - d. PROFLO
  - e. Trap-Wrap
  - f. Truebro, Inc.

## 2.2 PLUMBING FIXTURES, GENERAL

- A. Provide plumbing fixtures and trim, fittings, other components, and supports as specified on the drawings and below:

## 2.3 FAUCETS

- A. Faucets General: As described on the drawings.
  1. Electronic faucets shall be of the same manufacturer as the water closet and urinal flush valves.

## 2.4 STOP VALVES & SUPPLIES

- A. Supplies General: As described on the drawings.
  1. Exposed piping and parts shall be polished chrome plated.

## 2.5 P-TRAPS, DRAINS AND MISCELLANEOUS FITTINGS:

- A. Fittings General: As described on the drawings, except as listed below.
  1. Exposed piping and fittings shall be polished chrome plated.
  2. Fittings installed concealed inside a plumbing fixture or within wall construction may be without chrome plate finish.
  3. Fitting and faucet bodies for domestic water distribution shall be of lead free brass or lead free cast bronze.

- B. Sink Continuous Wastes: Polished chrome-plated, tubular brass, 1-1/2 inches, 17 gauge, with brass nuts on slip inlets, and of configurations indicated.
- C. Escutcheons: Wall flange with set screw.
- D. Escutcheons: Polished chrome-plated, sheet steel wall flange with friction clips.

## 2.6 FLUSHOMETERS

- A. Provide flushometers compatible with fixtures, with features and of consumption indicated as described on the drawings.
  - 1. Exposed metal parts shall be polished chrome plated.

## 2.7 TOILET SEATS

- A. General: As described on the drawings.

## 2.8 PLUMBING FIXTURE SUPPORTS

- A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.
- B. Support categories are:
  - 1. Carriers: Supports for wall-hanging water closets and fixtures supported from wall construction. Water closet carriers shall have an additional faceplate and coupling when used for wide pipe spaces. Provide tiling frame or setting gauge with carriers for wall-hanging water closets.
  - 2. Chair Carriers: Supports with steel pipe uprights for wall-hanging fixtures. Urinal chair carriers shall have bearing plates.
  - 3. Chair Carriers, Heavy Duty: Supports with rectangular steel uprights for wall-hanging fixtures.
  - 4. Reinforcement: 2-inch by 4-inch wood blocking between studs or 1/4-inch by 6-inch steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.
- C. Support Types: Provide support of category specified, of type having features required to match fixture.
- D. Provide supports specified as part of fixture description, in lieu of category and type requirements above.

## 2.9 INSULATION KITS

- A. Insulation kits for lavatory and sink waste and supplies of vinyl plastic with reusable fasteners and openings for access to supply stop handles.

# **PART 3 - EXECUTION**

## 3.1 INSTALLATION, GENERAL

- A. Install fixtures, trim and supports in accordance with manufacturer's installation instructions.

## 3.2 APPLICATION

- A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.
- B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:
  - 1. Carriers for following fixtures:
    - a. Wall-hanging water closets.
    - b. Wall hanging lavatories
    - c. Wall hanging electric water coolers.
    - d. Wall-hanging fixtures supported from wall construction.
  - 2. Chair carriers for the following fixtures:

- a. Wall-hanging urinals.
  - b. Wall-hanging lavatories and sinks.
  - c. Wall-hanging electric water coolers.
- 3. Heavy-duty chair carriers for the following fixtures:
  - a. Accessible lavatories.
  - b. Fixtures where specified.
- 4. Reinforcement for the following fixtures:
  - a. Urinal flush valve solid pipe ring supports.

### 3.3 INSTALLATION OF PLUMBING FIXTURES

- A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in drawings, and referenced standards.
- B. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gauge.
- C. Install wall-hanging, back-outlet urinals with gasket seals.
- D. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- E. Fasten floor-mounted fixtures and special fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- F. Fasten wall-mounted fittings to reinforcement built into walls.
- G. Fasten counter-mounting-type plumbing fixtures to casework.
- H. Secure supplies behind wall or within wall pipe space, providing rigid installation.
- I. Install stop valve in an accessible location in each water supply to each fixture.
- J. Install trap on fixture outlet except for fixtures having integral trap.
- K. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.
- L. Seal fixtures to walls, floors, and counters using a sanitary-type, one-part, mildew-resistant, silicone sealant in accordance with sealing requirements specified in Division 7 Section "Joint Sealers." Match sealant color to fixture color.
- M. Install insulation kits on ADA compliant sink and lavatory waste, continuous wastes, hot and cold water supplies where indicated on the drawings and as required by the ADA.

### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.
  - 2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

### 3.5 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.



### 3.6 ADJUSTING AND CLEANING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at electric water coolers, faucets, and flushometers having controls, to provide proper flow and stream.
- D. Replace washers of leaking and dripping faucets and stops.
- E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.
- F. Adjust faucet wrist blade handles perpendicular to the spout while in the closed position.
- G. Review the data in Operating and Maintenance Manuals. Refer to Division 1 Section "Project Closeout."

### 3.7 FIXTURE SCHEDULE

- A. Provide plumbing fixtures as specified on the drawings.
- B. Install rough-in for plumbing fixtures as scheduled on the drawings.

### 3.8 MOUNTING HEIGHTS SCHEDULE:

- A. Refer to the architectural drawings for plumbing fixture mounting heights. Unless indicated otherwise, install plumbing fixtures with the mounting heights as listed below with final approval by the Architect:

FIXTURE	MOUNTING HEIGHT
Ice Maker Outlet Boxes	24" floor to center of box
Washing Machine Outlet Boxes	42" floor to rim

**END OF SECTION 224000**

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## **SECTION 227000 - NATURAL GAS SYSTEMS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section includes distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:
  - 1. Pipes, fittings, and specialties.
  - 2. Special duty valves.
  - 3. Pressure regulators.
- B. Contractors Option:
  - 1. The Division 22 contractor may provide mechanically joined joints for natural gas systems to connect couplings, fittings, valves, and related components as an option in lieu of, in whole or in part, welded, threaded or flanged piping methods. Mechanically joined natural gas systems where used shall be provided in compliance with specification Section 227011 "Mechanically Joined Natural Gas Systems".
- C. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.
- D. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 22 Section "General plumbing Requirements," for trenching, excavation, backfill and compaction materials and methods for underground piping installations.
  - 2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.
  - 3. Division 9 Section "Painting," for materials and methods for painting pipe.
  - 4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations and wall and floor penetrations.
  - 5. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, unions, dielectric flanges, and mechanical sleeve seals.
  - 6. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting gas distribution piping.
  - 7. Division 26 Section "Common Work Results for Electrical" required electrical devices.
- E. Gas pressures for systems specified in this Section are limited to 2 psig.
- F. Products furnished under this Section include gas meters and gas service piping, which will be provided by the utility company to the site. The following is the name and address of the utility company:
  - Contact: Beverly Passantino
  - Company: Spire
  - Telephone number: (816) 472-3434

#### **1.2 DEFINITIONS**

- A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
- B. Gas Distribution Piping: A pipe within the building which conveys gas from the point of delivery to the points of usage.
- C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.
- D. Point of Delivery: The outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

#### **1.3 SUBMITTALS**

- A. Product data for each gas piping specialty and special duty valves. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

- B. Shop drawings detailing dimensions, required clearances, for connections to gas meter.
- C. Coordination drawings for gas distribution piping systems in accordance with Division 22 Section "General Plumbing Requirements."
- D. Maintenance data for gas specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
- E. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.
- F. Test reports specified in Part 3 below.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.
- B. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification."
- C. Regulatory Requirements: Comply with the requirements of the following codes:
  - 1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installation and inspections, testing, and purging of gas piping systems.
- D. Local Gas Utility Requirements: Comply with local gas utility installation rules and regulations.
- E. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

#### 1.5 SPARE PARTS

- A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:
  - 1. Gas Cocks – 2" and Smaller:
    - a. Homestead # 601
    - b. Milliken #200M
    - c. RM Energy Systems # D125
  - 2. CSA Listed Gas Pressure Regulators
    - a. Karl Dungs, Inc.
    - b. Maxitrol
    - c. Pietro-Florentini
  - 3. Insect Screens
    - a. Northtown Pipe Protection Products "BUGSCRN Series"

#### 2.2 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3, Article "PIPE APPLICATIONS" for identification of systems where the specified pipe and fitting materials listed below are used.

- B. Steel Pipe: ASTM A 53, Grade B, Schedule 40, (Type E electric-resistance welded or Type S seamless, black steel pipe, beveled ends).

## 2.3 FITTINGS

- A. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- B. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
  - 1. 1-1/4" and smaller shall be socket type
  - 2. 1-1/2" and larger shall be butt weld type.
- C. Forged Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, butt weld ends, standard pattern with bolts, nuts and gaskets of material group 1.1.

## 2.4 JOINING MATERIALS

- A. Joint Compound: Suitable for the gas being handled.

## 2.5 PIPING SPECIALTIES

- A. Protective Coating: When piping will be in contact with material or atmosphere exerting a corrosive action, pipe and fittings shall be factory-coated with polyethylene tape, having the following properties:
  - 1. overall thickness; 20 mils;
  - 2. synthetic adhesive;
  - 3. water vapor transmission rate, gallons per 100 square inch: 0.10 or less.
  - 4. water absorption, percent: 0.02 or less.
- B. Prime pipe and fittings with a compatible primer prior to application of tape.

## 2.6 VALVES

- A. Gas Cocks 2 Inch and Smaller: 175 psi, lubricated plug type, ASTM A126 Grade B semi-steel body, brass or semi-steel plug with full area rectangular port, straightaway pattern, square head, threaded ends.
- B. Gas Line Pressure Regulators: Single stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; internal relief vent, vent limiter for indoor installation, with threaded ends for 2 inch and smaller, for inlet and outlet gas pressures, specific gravity, and volume flow as indicated on the drawings.
  - 1. CSA listed for 2 PSI gas systems

# **PART 3 - EXECUTION**

## 3.1 INSTALLATION

- A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.

## 3.2 PREPARATION

- A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.
- B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

## 3.3 PIPE APPLICATIONS

- A. Install steel pipe with threaded joints and fittings for 2 inch and smaller.

### 3.4 PIPING INSTALLATION

- A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.
- B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.
- C. Dirt legs and Sediment Traps: Install a dirt leg at points where condensate and impurities may collect, at the outlet of the gas meter, as close to the inlet of each gas appliance or equipment as possible, and in a location readily accessible to permit cleaning and emptying.
  - 1. Construct dirt legs and sediment traps using a tee fitting with the bottom outlet plugged or capped. Provide a 3" length of pipe and screwed cap for the dirt leg. Use line size pipe for dirt leg, refer to the drawings for sizes. Enter the tee with flow from the top and exit the tee from the side outlet. Install the dirt leg a minimum of 3-1/2" above the roof or floor readily accessible to permit cleaning and emptying.
  - 2. Install line size gas cock, union and dirt leg at each equipment connection; refer to the drawings for sizes. Provide reducers at the equipment connection as required. Unions are specified in Division 22 section "Basic Piping Materials and Methods".
- D. Use fittings for all changes in direction and all branch connections.
- E. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- F. Install gas piping at a uniform grade of 1/4 inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.
- G. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.
- H. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.
- I. Install unions in pipes 2 inch and smaller, adjacent to each valve, and elsewhere as indicated. Unions are not required on flanged devices. Unions are specified in Section "Basic Piping Materials and Methods".
- J. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Dielectric unions and flanges are specified in Section "Basic Piping Materials and Methods".
- K. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.
- L. Anchor piping to ensure proper direction of expansion and contraction. Install expansion loops and joints as indicated on the Drawings and specified in Division 22 Section "Expansion Fittings and Loops for Plumbing Piping."
- M. Paint Exposed Outdoor Gas Piping: Cleaning and painting of exposed outdoor gas piping is specified in Division 9 Section "Painting".
  - 1. Final color per the architect.

### 3.5 HANGERS AND SUPPORTS

- A. Support gas piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table above for maximum spacing of supports. Support pipe at a minimum 7" above the roof.

### 3.6 PIPE JOINT CONSTRUCTION

- A. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:
  - 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.

2. Align threads at point of assembly.
3. Apply thread compound for use with gas systems to the external pipe threads. Pipe thread tape is not accepted.
4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
5. Damaged Threads: Do not use pipe with threads which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

### 3.7 VALVE APPLICATIONS

- A. General: The Drawings indicate valve types, locations, and arrangements.
- B. Shut-off duty: Use gas cocks specified in Part 2 above.

### 3.8 VALVE INSTALLATIONS

- A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.
- B. Install the emergency natural gas shutoff valve furnished with exhaust hood fire extinguishing system in an accessible location.
- C. Install laboratory gas cocks with inlet sized all thread shank and backing nut. Tighten backing nut to secured gas turret or gas cock to casework or wall. For wall mounted laboratory gas cocks, provide wood block backing in wall.
- D. Install line size gas cock at the outlet of the gas meter set or gas riser and install a line size union downstream of the gas cock outside of the building.
- E. Install seismic gas valve at gas meter downstream of house side gas cock and as required by the Authority Having Jurisdiction
- F. Installation of Gas Pressure Regulators:
  1. Install a gas cock 10 pipe diameters upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.
  2. Install gas pressure regulator relief devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.

### 3.9 TERMINAL EQUIPMENT CONNECTIONS

- A. Install line size gas cock upstream and within 6 feet of gas appliance. Install a line size union or flanged connection downstream from the gas cock to permit removal of controls. Install reducer at the gas appliance connection, if required.
- B. Install stainless steel flexible gas pipe connector, of size and length as required to complete equipment hook-up of foodservice equipment. Verify appropriate length of flexible gas pipe connector for movement of the foodservice equipment for cleaning.

### 3.10 ELECTRICAL BONDING AND GROUNDING

- A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."
- B. Do not use gas piping as a grounding electrode.
- C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

### 3.11 FIELD QUALITY CONTROL

- A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

**END OF SECTION 227000**



## **SECTION 227010 - MECHANICALLY JOINED NATURAL GAS PIPING SYSTEMS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section includes mechanically joined fittings and valves for distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:
  - 1. Fittings.
- B. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.
- C. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 22 Section "Natural Gas Systems," for valves, hangers, natural gas systems and installation requirements.
- D. Gas pressures for systems specified in this Section are limited to 2 psig.

#### **1.2 SUBMITTALS**

- A. Product data for each mechanically joined gas pipe fitting. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.
- B. Maintenance data for mechanically joined gas pipe fittings, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
- C. Installer qualification certificates, certifying that installers comply with the quality requirements specified under "Quality Assurance" below.
- D. Test reports specified in Part 3 below.

#### **1.3 QUALITY ASSURANCE**

- A. Installer Qualifications: Installation of mechanically joined fittings shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.
- B. Local Gas Utility Requirements: Installation of mechanically joined fittings shall comply with local gas utility installation rules and regulations.
- C. Mechanically joined fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- D. Obtain training from the mechanically joined fittings manufacturer for all workers that will be installing or handling the mechanically joined fittings.

### **PART 2 - PRODUCTS AND MATERIALS**

#### **2.1 MANUFACTURERS**

- A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:
  - 1. Mechanically Joined Fittings:
    - a. Viega "Mega-Press G Fittings"

- b. Apollo "PowerPress"
- c. Mueller Streamline STL

## 2.2 FITTINGS

- A. Mechanically Joined Fittings: ½ inch through 4 inch meeting ANSI LC4-2012 /CSA 6.32-2012 2nd Edition with zinc/nickel coating, HNBR sealing element, 420 stainless steel grip ring, 304 stainless steel separator ring, and Smart Connect (SC) Feature that allows the joint to leak if not properly sealed. Fittings shall be for use with IPS schedule 10 thru schedule 40 carbon steel, or galvanized pipe meeting ASTM A53. Fittings shall have temperature and pressure rating of -40F to 180F at a maximum operating pressure of 125 psi.

## **PART 3 - EXECUTION**

### 3.1 PIPING INSTALLATION

- A. Install fittings and valves in accordance with manufacturer's installation instructions.

### 3.2 PREPARATION

- A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.
- B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

### 3.3 PIPE APPLICATIONS

- A. Install above floor steel pipe with mechanically joined fittings for pipe 1/2 inch and larger up to 4".

### 3.4 PIPING INSTALLATION

- A. Piping Installation requirements are specified in Division 22 Section "Natural Gas Systems".

### 3.5 PIPE JOINT CONSTRUCTION

- A. Joint materials and installation requirements are specified in Division 22 Section "Natural Gas Systems".
- B. Joints for Mechanically Joined Fittings: Comply with the manufacturer's installation instructions and Requirements:
  - 1. Cut pipe ends at right angle (square) to the pipe.
  - 2. Ream pipe ends with chamfer.
  - 3. Remove paint, lacquer, grease, oil or dirt from the pipe end with an abrasive cloth, or with the "Ridgid MegaPress" pipe end prep tool.
  - 4. Visually examine the fitting sealing element to ensure there is no damage.
  - 5. Utilize a "Viega MegaPress Insertion Depth Inspection Gauge" to mark the pipe wall, with a felt tip pen, at the appropriate location, or insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting.
  - 6. Verify the pipe is fully inserted into the fitting prior to pressing the joint.
  - 7. Install mechanically joined fittings using "Ridgid" MegaPress Tools.

### 3.6 VALVE APPLICATIONS

- A. Valves are specified in Division 22 Section "Natural Gas Systems".
- B. Valves can be installed with screwed joints for 2" and smaller.

### 3.7 VALVE INSTALLATIONS

- A. Valve installation requirements are specified in Division 22 Section "Natural Gas Systems".

### 3.8 FIELD QUALITY CONTROL

- A. Field quality control requirements are specified in Division 22 Section "Natural Gas Systems".
- B. Installing contractor shall schedule training session with the mechanically joined fittings manufacturer at project site for all workers that will be installing or handling mechanically joined fittings. Submit certification letter along with list of certified attendees to Architect within 30-days of mobilization. Include copy of certification letter with closeout documents. Mechanically joined fittings manufacturer shall provide certification training to the contractor without cost and without additional cost to the Owner.
- C. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.
- D. Manufacturer's Piping Test: Provide two-step test process as follows:
  - 1. Pressurize the system between 0.5 psi and 45 psi with air or dry nitrogen.
  - 2. If the system does not hold pressure, walk the system and check for un-pressed fittings.
  - 3. If un-pressed fittings are found, ensure the pipe is fully inserted into the fitting and properly marked prior to pressing the joint.
  - 4. If failed joints are found, cut out the failed fitting and replace with new as specified herein.
  - 5. After appropriate repairs have been made, test the system per local code, not to exceed 200 psig.

**END OF SECTION 227010**

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## **SECTION 230010 - GENERAL MECHANICAL REQUIREMENTS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 DESCRIPTION OF WORK**

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; 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 materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

#### **1.2 QUALITY ASSURANCE**

- A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

#### **1.3 CODES, REFERENCES AND STANDARDS**

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

BOCA	Building Officials Code Administration
UBC	Uniform Building Code
UMC	Uniform Mechanical Code

UPC	Uniform Plumbing Code
IBC	International Building Code
IMC	International Mechanical Code
IPC	International Plumbing Code
IECC	International Energy Conservation Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
ADA	American Disabilities Act
ADC	Air Diffusion Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

#### 1.4 DEFINITIONS

##### A. General:

1. **Furnish:** The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
2. **Install:** The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. **Provide:** The term "provide" means "to furnish and install, complete and ready for the intended use. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
5. **Engineer:** Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. **AHJ:** The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. **NRTL:** Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required

- and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
    - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
    - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
  9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. The following definitions apply to excavation operations:
1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
  2. Bedding: Bedding as used in this section refers to the compacted sand or pea gravel installed in the bottom of a trench to immediately support and cover a pipe or duct.
  3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
  4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
  5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.
  6. Building Fill: Building fill as used in this section refers to borrowed fill material of rock 1" and larger used to fill foundation excavations

## 1.5 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.
- D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate the work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

- F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

## 1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.
1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
  2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
  3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
  4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
  5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
  6. Indicate required installation sequence to minimize conflicts between entities.
  7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
  8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
  2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
  3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
  4. Include work provided by others routed through the equipment rooms.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
  2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
    - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
  3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
  4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

## 1.7 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.



## 1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. Submittals shall contain the following information:
  - 1. The project name.
  - 2. The applicable specification section and paragraph.
  - 3. Equipment identification acronym as used on the drawings.
  - 4. The submittal date.
  - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
  - 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.
- M. Provide welders' qualification certificates.

## 1.9 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

## 1.10 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
  - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
  - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
  - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
    - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
    - d. Same warranty will be furnished for proposed substitution as for specified Work.
    - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
  - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
  - 2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
  - 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
  - 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

## 1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address

and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

- E. Each manual shall contain data listed in each individual Section.
- F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representative.

#### 1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification.

#### 1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

#### 1.14 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

#### 1.15 PAINTING

- A. Exposed ductwork and ferrous surfaces, including pipe, pipe hangers, equipment stands and supports [and exposed insulated piping] shall be painted by the Contractor using materials and methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.
- B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.
- C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

#### 1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material

stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

- D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

#### 1.17 GUARANTEES AND WARRANTIES

- A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
- C. The following additional items shall be guaranteed:
  - 1. Piping shall be free from obstructions, holes or breaks of any nature.
  - 2. Insulation shall be effective.
  - 3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

#### 1.18 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
  - 1. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.
  - 2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, non-clogged condition during construction period.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
  - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
  - 2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees Fahrenheit. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

#### 1.19 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting their bid to determine the nature and extent of work involved.
  2. Work in the existing building shall be scheduled with the Owner.
  3. Certain demolition work must be performed prior to the remodeling. The Mechanical Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.
  4. Mechanical Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Mechanical Contractor during this demolition shall become their property and shall be removed by the Mechanical Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
  5. Mechanical Contractor shall relocate and reconnect Mechanical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Mechanical equipment or materials are removed, the Mechanical Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
  6. General Contractor shall install finish material.
  7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
  8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
  9. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
1. Maintain and protect existing building services which transit the area affected by selective demolition.
  2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- D. Use of explosives is not permitted.
- E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 NOT USED**

## **PART 3 - EXECUTION**

### **3.1 PERMITS**

- A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

### **3.2 EXISTING UTILITIES**

- A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.
- B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

- C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.
- D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.
- E. Contractor shall include in their bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

### 3.3 SELECTIVE DEMOLITION

- A. Refer to Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment to Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- E. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
  - 1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, and insulation.
    - a. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
    - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 23.
- F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
  - 1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

### 3.4 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

### 3.5 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.

- B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

### 3.6 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
  - 1. Submit complete Operation and Maintenance Manuals.
  - 2. Submit complete Record Drawings.
  - 3. Perform special inspections as required in each individual Section.
  - 4. Start-up testing of systems.
  - 5. Removal of temporary facilities from the site.
  - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, the Contractor shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

### END OF SECTION 230010

## SUBSTITUTION REQUEST FORM

To Project Engineer: \_\_\_\_\_ Request # (GC Determined): \_\_\_\_\_

Project Name: \_\_\_\_\_

Project No/Phase: \_\_\_\_\_ Date: \_\_\_\_\_

Specification Title: \_\_\_\_\_

Section Number: \_\_\_\_\_ Page: \_\_\_\_\_ Article/Paragraph: \_\_\_\_\_

Proposed Substitution: \_\_\_\_\_

Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_

Address: \_\_\_\_\_ Phone: \_\_\_\_\_

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: \_\_\_\_\_

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples  
☐ Tests ☐ Reports ☐ Other: \_\_\_\_\_

Reason for not providing specified item: \_\_\_\_\_

Similar Installation:

Project: \_\_\_\_\_ Architect: \_\_\_\_\_

Address: \_\_\_\_\_ Owner: \_\_\_\_\_

Date Installed: \_\_\_\_\_

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: \_\_\_\_\_



**Substitution Certification Statement:**

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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**Manufacturer's Certification of Equal Quality:**

I \_\_\_\_\_ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
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**Engineer Review and Recommendation Section**

Recommend Acceptance	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Additional Comments:	<input type="checkbox"/> Attached	<input type="checkbox"/> None

**Acceptance Section:**

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

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## **SECTION 230015 - ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This Section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.
- C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

#### **1.2 SUBMITTALS**

- A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

#### **1.3 QUALITY ASSURANCE**

- A. Electrical components and materials shall be UL labeled.
- B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

### **PART 2 - PRODUCTS AND MATERIALS**

#### **2.1 GENERAL**

- A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.
- B. Refer to Division 26, "COMMON WORK RESULTS FOR ELECTRICAL" for specification of motor connections.
- C. Refer to Division 26, "ENCLOSED CONTROLLERS" for specification of motor starters.
- D. Refer to Division 26, "ENCLOSED SWITCHES AND CIRCUIT BREAKERS" for specification of disconnect switches and enclosed circuit breakers.

### **PART 3 - EXECUTION**

#### **3.1 CONTRACTOR COORDINATION**

- A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

- B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

**TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT**

ITEM	FURN BY	SET BY	POWER CONTROL WIRING WIRING	
Equipment motors	DIV23m	DIV23m	DIV26	---
Factory furnished motor starters	DIV23m	DIV23m	DIV26	DIV23t
contactors and disconnects				
Variable speed drives	DIV23m	DIV23m	DIV26	DIV23t
Control relays	DIV23t	DIV23t	DIV26	DIV23t
Thermostats (low voltage)	DIV23t	DIV23t	---	DIV23t
Thermostats (line voltage)	DIV23m	DIV23m	DIV26	---
Time switches	DIV23t	DIV23t	DIV26	DIV23t
(for mechanical equipment)				
Control power transformers	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers	DIV23m	DIV23m	DIV26	DIV23t
furnished with equipment				
Temperature control panels	DIV23t	DIV23t	DIV26	DIV23t
(housing controllers)				
Building controllers, advanced	DIV23t	DIV23t	DIV23t	DIV23t
application controllers, and				
application specific controllers				
Motor and solenoid operated valves	DIV23t	DIV23m	DIV23t	DIV23t
Damper operators, PE & switches	DIV23t	DIV23t	DIV23t	DIV23t
Smoke dampers and combination	DIV23m	DIV23m	DIV26	DIV28
fire/smoke dampers				
Smoke dampers for smoke	DIV23t	DIV23m	DIV26	DIV23t/28
control system				
Duct Smoke detectors	DIV28	DIV23m	DIV28	DIV28
Interlocks between HVAC fans	---	---	DIV26	DIV23t
and damper operators				

DIV23m = Mechanical Contractor

DIV23t = Temperature Controls Sub-Contractor

DIV26 = Electrical Contractor

DIV28 = Electronic Safety and Security

**END OF SECTION 230015**

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## **SECTION 230500 - COMMON WORK RESULTS FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.
- B. Mechanical equipment nameplate data.
- C. Concrete for bases and housekeeping pads.
- D. Non-shrink grout for equipment installations.
- E. Sleeves for mechanical penetrations.
- F. Drip Pans with detection.
- G. Miscellaneous metals for support of mechanical materials and equipment.
- H. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.
- I. Joint sealers for sealing around mechanical materials and equipment.
- J. Plenum insulation for enclosure of combustible items located within fire-rated plenums.
- K. Firestopping

#### **1.2 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 23 Section General Mechanical Requirements.
  - 1. Product data for the following products:
    - a. Access panels and doors.
    - b. Joint sealers.
    - c. Through and membrane-penetration firestopping systems.
  - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
  - 3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
  - 4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
    - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."
  - 5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
    - a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

#### **1.3 QUALITY ASSURANCE**

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
  - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
  - 1. Provide UL Label on each fire-rated access door.
- C. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 ACCESS TO EQUIPMENT**

- A. Manufacturers:
  - 1. Bar-Co., Inc.
  - 2. Elmdor Stoneman.
  - 3. JL Industries
  - 4. Jay R. Smith Mfg. Co.
  - 5. Karp Associates, Inc.
  - 6. Milcor
  - 7. Nystrom Building Products
  - 8. Wade
  - 9. Zurn
- B. Access Doors:
  - 1. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
  - 2. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
    - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
    - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
    - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
  - 3. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
    - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
  - 4. Locking Devices: Flush, screwdriver-operated cam locks.

### **2.2 MECHANICAL EQUIPMENT NAMEPLATE DATA**

- A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

### **2.3 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS**

- A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted mechanical equipment. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.
- B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.
- C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the



latest applicable recommendations of the ACI standard practice manual. Concrete shall be composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.

- D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x W2.9 welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24" on center with a minimum of two bars each direction.
- E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.
- F. Concrete equipment bases and housekeeping pads shall have height as specified on the drawings or minimum height if not specified in accordance with the following table:

Equipment	Minimum Height
Furnaces, Exterior Equipment Less than or equal to 20 tons and Other Equipment Not Listed	3-1/2"
Air Handling Units w/TSP less than or equal to 3.5", Boilers (See Note 1)	3-1/2"
All Vertical Inline Pumps,	5-1/2"

NOTES:

- 1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.
- 2. Coordinate final pad heights for air handling units with required condensate trap depths. Increase pad heights as needed to allow for unit trap height and required slope to drain.

## 2.4 GROUT

- A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.
- B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.
- C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

## 2.5 PENETRATIONS

- A. Sleeves:
  - 1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
  - 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
- B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

## 2.6 DRIP PANS

- A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2" lapped and soldered joints. Drip pan shall have a depth of 2" and a width of 6" in addition to the diameter of the associated pipe. Provide 3/4" galvanized pipe with male NPT outlet at low point of drip pan. Connect 3/4" type "L" copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.

- B. Drip pan supports shall be ¼" X 2" galvanized bar stock welded to the drip pan without holes. Provide ¼" galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.
- C. Flood Detector: Flood detector switch utilizing hydrophilic pad and stainless steel sensor array to detect moisture. Switch shall be provided with integral feet to prevent pad from contacting the pan. Provide with solid state electronics and double throw relay to allow switch to shut down unit and provide an auxiliary alarm output.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Diversitech
    - b. RCT/Aquaguard
    - c. Approved equivalent

## 2.7 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

## 2.8 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

## 2.9 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
  - 1. Manufacturers:
    - a. Dow Corning, Dowsil 790.
    - b. Dow Corning, Dowsil 795.
    - c. GE, Silglaze II SCS 2350.
    - d. GE, Silpruf SCS 2000.
    - e. Owens Corning, Energy Complete.
    - f. Pecora, 864 NST.
    - g. Tremco, Spectrem 1.
    - h. Tremco, Spectrem 2.
- D. High Humidity Sealer: One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
  - 1. Manufacturers:
    - a. Dow Corning, Dowsil 786.
    - b. GE, Momentum SCS1700.
    - c. Pecora, 898 Silicone NST.

- E. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.
  - 1. Manufacturers:
    - a. BASF, MasterSeal NP 100.
    - b. Pecora, DyanTrol I-XL.
    - c. Tremco, Dymonic FC.
- F. Acrylic Latex Joint Sealer: One-part, non-sag, mildew-resistant, paintable acrylic latex or siliconized acrylic latex, complying with ASTM C834, Type OP, Grade NF, recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
  - 1. Manufacturers:
    - a. Pecora, AC-20
    - b. Sherwin Williams 950A
    - c. Tremco, Tremflex 834

## 2.10 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E814, or other NRTL acceptable to AHJ.
- B. Manufacturers:
  - 1. 3M Corp., Fire Barrier Sealant.
  - 2. Hilti.
  - 3. Owens Corning, Firestopping Insulation.
  - 4. Pecora, AC-20 FTR.
  - 5. RectorSeal.
  - 6. Specified Technologies Inc., Firestop.
  - 7. USG SHEETROCK Firecode Compound.
  - 8. Tremco, Tremstop Fyre-Sil.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION, GENERAL

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

### 3.2 INSTALLATION OF ACCESS DOORS

- A. Provide access doors for all concealed equipment and duct and piping accessories that require service where indicated or as required, except where above lay-in ceilings. Refer to Section "Identification for HVAC Piping and Equipment" for labeling of access doors.
- B. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
- C. Access doors must be of the proper construction for type of construction where installed.
- D. The exact location of all access doors shall be verified with the Architect prior to installation.
- E. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- F. Adjust hardware and panels after installation for proper operation.

### 3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

- B. Field Welding: Comply with AWS "Structural Welding Code."

#### 3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

#### 3.5 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

#### 3.6 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
  - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
  - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

#### 3.7 PENETRATIONS:

- 1. .
- B. Construction in Existing Facilities:
  - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
- C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.
- D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.
- E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.
- F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.
- G. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.
- H. Cut sleeves to length for mounting flush with both surfaces of walls.
- I. Extend sleeves installed in floors 2 inches above finished floor level.

- J. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- K. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.
- L. All circular and oval openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 23 Section "Basic Piping Materials and Methods". All rectangular openings through underground exterior walls shall be flanged and flashed with non-corrosive material on each side and the gap sealed with weatherproof sealant.

**END OF SECTION 230500**

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## **SECTION 230510 - BASIC PIPING MATERIALS AND METHODS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SECTION INCLUDES**

- A. Joining materials.
- B. Escutcheons.
- C. Nipples.
- D. Unions.
- E. Dielectric unions.
- F. Dielectric flanges and flange kits.
- G. Mechanical sleeve seals.

#### **1.2 SUBMITTALS**

- A. Refer to Division 01 and Division 23 Section "General Mechanical Requirements" for administrative and procedural requirements for submittals.
- B. Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.
- C. Quality Assurance Submittals: Submit welders' certificates specified in Article "Quality Assurance" below.
- D. Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system application in the project including manufacturer's catalog information, pipe materials, sizes, fittings, Type, Grade, Schedule, applicable ASTM standard, and connection method(s).
- E. Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.
- F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.
- G. Manufacturer's Installation Instructions: Indicate hanging and support methods and joining procedures.
- H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- I. Shop Drawings: Include detailed fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.
- J. Coordination Drawings: Include piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Other building services.
  - 3. Structural members.
- K. As-built drawings for each piping system in electronic and PDF format.
- L. Refer to the individual piping system specification sections in Division 23 for additional requirements.

### 1.3 QUALITY ASSURANCE

- A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code (BPVC), Section IX, "Welding, Brazing, and Fusing Qualifications."
- B. Comply with ASME B31.9 - Building Services Piping, most recent edition.
- C. Comply with American Welding Society (AWS), Welding Handbook, most recent edition.
- D. Soldering and Brazing procedures shall conform to ANSI B9.1 Safety Code for Mechanical Refrigeration.
- E. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ASME, and ANSI standards.
- F. Refer to the individual piping system specification sections in Division 23 for additional requirements.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- C. Refer to the individual piping system specification sections in Division 23 for additional requirements.

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 PIPE AND FITTINGS

- A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

### 2.2 JOINING MATERIALS

- A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Welding Materials: Comply with AWS D10.12 and Section II, Part C, ASME BPVC for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- D. Brazing Filler Metals: Comply with SFA-5.8, Section II, ASME BPVC for brazing filler metal materials appropriate for the materials being joined.
  - 1. AWS A5.8, Classification BAg-5:
    - a. Silver (Ag) 44.0 – 46.0 percent.
    - b. Zinc (Z) 23.0 – 27.0 percent.
    - c. Copper (Cu) 29.0 – 31.0 percent.
  - 2. AWS A5.8, Classification BCuP-5:
    - a. Phosphorus (P) 4.8 - 5.2 percent.
    - b. Silver (Ag) 14.5 - 15.5 percent.
    - c. Copper (Cu) remainder.
- E. Soldering Filler Metals: ASTM B32, 95-5 Tin-Antimony and water flushable flux in accordance with ASTM B813.
- F. Gaskets for Flanged Joints: ASME B16.21, full-faced for cast-iron flanges and raised-face for steel flanges. Select material, thickness, and type to suit the service of the piping system in which installed and which conform to their respective ASME Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.



## 2.3 ESCUTCHEONS

- A. Manufacturers:
  - 1. AWI Manufacturing.
  - 2. Keeney Manufacturing Company.
  - 3. Wal-Rich Corp.
  - 4. Jones Stephens Corp.
  - 5. Approved equal.
- B. Chrome-plated, stamped-steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

## 2.4 NIPPLES

- A. Steel: ASTM A733, made of ASTM A53, Schedule 40, black steel; Type S seamless for pipe sizes 2 inch and smaller, Type E electric-resistance welded for pipe sizes 2-1/2 inch and larger.

## 2.5 UNIONS:

- A. Manufacturers:
  - 1. Anvil International.
  - 2. Hart Industries.
  - 3. Mueller Streamline Co.
  - 4. Victaulic Company of America.
  - 5. Watts Regulator Co.
  - 6. Approved equal.
- B. Hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
  - 1. Malleable-iron: ASME B16.39, class as specified in section "Hydronic Piping" for the piping system used.
  - 2. Bronze: ASME B16.15, cast bronze body meeting ASTM B62, class as specified in section "Hydronic Piping" for the piping system used.
  - 3. Copper: ASME B16.22 wrought copper body.
    - a. For hydronic systems, provide class as specified in section "Hydronic Piping" for the piping system used.
    - b. For refrigerant systems, provide pressure rating as required for the refrigerant type used.

## 2.6 DIELECTRIC UNIONS

- A. Manufacturers:
  - 1. Hart Industries.
  - 2. Victaulic Company of America.
  - 3. Watts Regulator Co.
  - 4. Approved equal.
- B. Factory-fabricated with cast bronze body meeting ASTM B584 and galvanized or black steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

## 2.7 DIELECTRIC FLANGES AND FLANGE KITS

- A. Manufacturers:
  - 1. Advance Products & Systems, Inc.
  - 2. Calpico, Inc.
  - 3. Pipeline Seal & Insulator, Inc.
  - 4. Tampa Rubber & Gasket Co. Inc.
  - 5. Watts Water Technologies.
  - 6. Approved equal.

- B. Full-faced gasket with same outside diameter and bolt hole arrangement as the flange. Conform to ANSI B16.5. Pressure rating of 200 psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.
- C. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.
- D. Flanges: Cast bronze meeting ASTM B584, class 125 solder type or cast iron meeting ASTM A536, class 125 threaded type for low pressure service, bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

## 2.8 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
  - 1. Thunderline/Link Seal.
  - 2. Calpico, Inc.
  - 3. Metraflex Co.
  - 4. Approved equal.
- B. Sleeves: Refer to Division 23 Section "Common Work Results for HVAC" for sleeve materials.
- C. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

## **PART 3 - EXECUTION**

### 3.1 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

### 3.2 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations. Provide deep pattern escutcheons where required to conceal protruding pipe fittings.
- D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

- I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.
- J. Verify final equipment locations for roughing in.
- K. Use fittings for all changes in direction and all branch connections.
- L. Remake leaking joints using new materials.
- M. Install components with pressure rating equal to or greater than system operating pressure.
- N. Piping Protection:
  - 1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
  - 2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

### 3.3 PENETRATIONS

- A. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies. Reference Division 23 Section "Common Work Results for HVAC" for additional penetration requirements.
- B. Above Grade Concrete or Masonry Penetrations:
  - 1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs.
    - a. Provide Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
    - b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
    - c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:
      - 1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).
      - 2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).
    - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
  - 2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.
  - 3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.
- C. Interior Foundation Penetrations:
  - 1. Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.
- D. Concrete Slab on Grade Penetrations:
  - 1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.
  - 2. Provide 1/2 inch thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2 inches above and below the concrete slab.
- E. Interior Penetrations of Non-Fire-Rated Walls:
  - 1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
  - 2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.
- F. Fire / Smoke Rated Floor and Wall Assemblies:
  - 1. Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the

manufacturer's UL listing. Refer to Division 07 Section "Penetration Firestopping" for special sealers and materials.

### 3.4 PIPE JOINT CONSTRUCTION

- A. Threaded Joints:
  - 1. Provide tapered pipe threads for field cut threads. Cut threads full and clean using sharp dies.
  - 2. Ream threaded pipe ends to remove burrs and restore full inner diameter.
  - 3. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine how far pipe should be threaded into joint.
  - 4. Align threads at point of assembly.
  - 5. Apply appropriate tape or thread compound to the male pipe threads except where dry seal threading is specified.
  - 6. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded. Tighten joint to leave not more than 3 threads exposed.
  - 7. Damaged Threads: Do not use pipe or pipe fittings with threads which are corroded or damaged.
- B. Flanged Joints:
  - 1. Select appropriate gasket material, size, type, and thickness for service application.
  - 2. Install gasket concentrically positioned.
  - 3. Align flanges surfaces parallel.
  - 4. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible.
  - 5. Use suitable lubricants on bolt threads.
  - 6. Tighten bolts gradually and uniformly using torque wrench.
- C. Welded Joints:
  - 1. Comply with the requirement in ASME Code B31.9, "Building Services Piping."
  - 2. Damaged Welds: Do not use pipe sections that have cracked or open welds.
- D. Brazed and Soldered Joints:
  - 1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
  - 1. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
  - 2. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
  - 3. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
    - 1. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making joint.
    - 2. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
  - 4. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.
  - 5. Dissimilar metals such as copper and brass shall be jointed using an appropriate flux with either BCuP-5 or BA-g-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.
  - 6. Continuously purge the pipe and fittings during brazing with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.
  - 7. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
  - 8. Provide temporary cap or cover on completed joints with open ends to prevent entry of contaminating materials.
- B. Joints for other piping materials are specified within the respective piping system Sections.

### 3.5 UNIONS

- A. Install unions on pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

### 3.6 DIELECTRIC UNIONS

- A. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
2. Install waterway fittings where installation is concealed. Do not install dielectric unions in concealed spaces.

### 3.7 DIELECTRIC FLANGES AND FLANGE KITS

A. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
2. Install waterway fittings where installation is concealed. Do not install dielectric flanges in concealed spaces.

C. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.

D. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.

E. Provide full face gasket with pressure rating equal to system served.

F. At each bolt provide steel washers, thermoplastic washers, and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

### 3.8 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

## END OF SECTION 230510

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## **SECTION 230513 - COMMON MOTOR REQUIREMENT FOR HVAC EQUIPMENT**

### **PART 1 - GENERAL**

#### 1.1 SECTION INCLUDES

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

#### 1.2 SUBMITTALS

- A. Conform with the submittal procedures in Division 01.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Provide nameplate data and ratings, mounting arrangements, size and location of winding termination lugs, overload relays, conduit entry, grounding lug, and coatings.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

#### 1.3 QUALITY ASSURANCE

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

#### 1.4 DELIVERY STORAGE AND HANDLING.

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

#### 1.5 WARRANTY

- A. Provide five-year manufacturer warranty for motors larger than 20 horsepower.

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 MANUFACTURERS

- A. Baldor Electric Company.

- B. General Electric.
- C. Gould.
- D. Marathon.
- E. Regal-Beloit Corporation (Century).
- F. Westinghouse

## 2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.
  - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
  - 2. Motors 3/4 HP and Larger: Voltage as scheduled, three phase, 60 Hz.
- B. Construction:
  - 1. Open drip-proof except where noted otherwise.
  - 2. Design for continuous operation in 104 degrees F environment.
  - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
  - 4. Motors with frame sizes 254T and larger: Energy Efficient Type.
- C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
- D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- E. Wiring Terminations:
  - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
  - 2. For fractional horsepower motors where connection is made directly, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

## 2.3 APPLICATIONS

- A. Exception: Motors less than 250 Watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.
- B. Single phase motors for oil burner: Split phase type.
- C. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
- D. Single phase motors for fans, pumps, blowers and air compressors: Capacitor start type.
- E. Single phase motors for fans less than 1 hp and greater than 1/12 hp: Electronically commutated type.
- F. Motors located in exterior locations, air cooled condensers, humidifiers and explosion proof environments: Totally enclosed fan cooled type.
- G. Motors located outdoors in wet airstreams, including but not limited to cooling towers, evaporative condensers, and sprayed coils: Totally enclosed weatherproof epoxy-sealed type.
- H. bearings.

## 2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

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



- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

## 2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

## 2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Drip-proof Enclosure: NEMA Service Factor.
- G. All motors controlled by variable frequency controllers shall have a 1.15 Service Factor.
- H. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- I. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- J. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Division 26 - Motor Controlling Equipment.
- K. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- L. Sound Power Levels: To NEMA MG 1.
- M. All totally enclosed motors shall be fan cooled type. Non-ventilated type motors are not acceptable.
- N. Motors controlled by variable frequency drives:

1. Rated for voltage peaks and minimum rise times in accordance with NEMA MG1, Part 31.
2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
3. Inverter-Duty Motors: Class B temperature rise; Class F insulation.
4. Grounding: Provide shaft grounding system equal to AEGIS SGR Bearing Protection Ring, Inpro/Seal Current Diverter Ring (CDR) or approved equal. Install system in accordance with manufacturer's recommendations.
5. Motor Overload Relay: When a single drive is used to supply power to multiple motors, provide a solid state 3-phase adjustable overload relay between the drive and each motor.
  - a. Relay shall have manual reset.
  - b. Provide alarm contact with automatic reset overloads.

O. Part Winding Start, Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

P. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

Q. Nominal Efficiency: Motors shall have minimum NEMA premium efficiency at full load and rated voltage when tested in accordance with IEEE 112.

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

## 2.7 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.

B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.

C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.

D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

## 2.8 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 23 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.
2. All welded steel housing.
3. Each capacitor internally fused.
4. Non-flammable synthetic liquid impregnated.
5. Craft tissue insulation.
6. Aluminum foil electrodes.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

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

B. Install securely on firm foundation.

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

D. Install motor overload relays in a common enclosure adjacent to the variable frequency drive

### 3.2 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

### 3.3 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	RPM (Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	84	73
2	1200	184T	85.5	75
3	1200	213T	86.5	60
5	1200	215T	87.5	65
7-1/2	1200	254T	88.5	73
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86.5	86
5	1800	184T	87.5	87
7-1/2	1800	213T	88.5	86
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	145T	84	85
5	3600	182T	85.5	86
7-1/2	3600	184T	87.5	88

### 3.4 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM (Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	85.5	65
2	1200	184T	86.5	68
3	1200	213T	87.5	63
5	1200	215T	87.5	66
7-1/2	1200	254T	89.5	68
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	87.5	83
5	1800	184T	87.5	83
7-1/2	1800	213T	89.5	85

**END OF SECTION 230513**

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## **SECTION 230514 - VARIABLE FREQUENCY DRIVES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Variable speed drives shall be furnished for those units so indicated on the drawings. All variable speed drives provided under this section shall be by the same manufacturer.
- B. Type of variable speed drive specified in this Section include the following:
  - 1. Pulse Width Modulated

#### **1.2 CODES AND STANDARDS:**

- A. The VFD shall meet the following standards.
  - 1. Institute of Electrical and Electronic Engineers (IEEE)
    - a. Standard 519-2014 IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
  - 2. Nationally recognized testing lab such as UL or ETL
    - a. UL 508C (Variable frequency drive)
    - b. UL 508A (Bypass)
  - 3. NEMA – ICS 7.0, AC Adjustable Speed Drives

#### **1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
  - 1. Product Data: Submit manufacturer's technical product data for variable speed drive including dimensions, capacities, component performance data, ratings, features, motor electrical characteristics, over current protection rating, gages and finishes of material, and installation instructions.
  - 2. Shop Drawings: Submit assembly-type shop drawings including unit dimensions, required clearances, control description, construction details, and field connection details.
  - 3. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to variable speed drives. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
  - 4. Maintenance Data: Submit maintenance instructions, including instructions for adjustments, troubleshooting, operation, testing and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 1 and Division 23 Section "General Mechanical Requirements."
  - 5. Harmonic Analysis Report: Provide project-specific calculations and manufacturer's statement of compliance with IEEE 519.

#### **1.4 QUALITY ASSURANCE**

- A. Testing: The variable speed drive, all components and subassemblies shall be factory tested. The variable speed drive shall be tested and cycled under motor load.
- B. Reliability: A complete description of supplier's Quality Assurance and Testing program shall be provided.
  - 1. Component Testing: All power semiconductors and integrated circuits shall be 100% tested.
  - 2. Computerized ATE Testing: Computerized Automated Testing Equipment (ATE) testing shall be used to evaluate functional performance of printed circuit boards. Printed circuit boards shall receive a thermal stress test where temperatures are cycled between 0°C and 65°C and receive electrical power-on and power-off cycle tests.
  - 3. Burn In: All VFD's shall be tested/run in the equivalent of a NEMA 1 or NEMA 3R as indicated on the schedule, enclosure and burned in at rated ambient (40°C) with a fully loaded motor.

#### **1.5 WARRANTY**

- A. Provide warranty including on site parts and labor for minimum 36 months from date of shipment.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 GENERAL:**

- A. Provide factory assembled and factory tested variable speed drives as indicated, of sizes and capabilities as scheduled, and as specified herein.

### **2.2 MANUFACTURERS:**

- A. Subject to compliance with requirements, manufacturers offering variable speed drives which may be incorporated in the work are limited to the following:
  - 1. ABB.
  - 2. Danfoss.
  - 3. Delta Controls
  - 4. Eaton/Cutler-Hammer.
  - 5. Franklin Control Systems.
  - 6. Invertek.
  - 7. Square D, a division of Schneider Electric.
  - 8. Yaskawa Electric America.

### **2.3 VARIABLE FREQUENCY DRIVES**

- A. The VFD shall provide the following design features as standard:
  - 1. Input Section: Full wave rectification shall be achieved with input diodes in a conventional bridge configuration and shall be used to supply voltage to the DC bus. Drive shall be provided with dual DC bus chokes or AC line reactors, as required, for a total input impedance of 5% or better.
  - 2. Output Section: The inverter shall use power transistors to provide three phase output power to the motor.
  - 3. Input Displacement Power Factor: The input displacement power factor shall be 0.97 or higher at all operating speeds and loads.
  - 4. Microprocessor Logic: The VFD shall be microprocessor based and utilize digital input for all parameter adjustments. Use of potentiometers for parameter adjustment is not acceptable.
  - 5. Auto Restart: The VFD shall automatically attempt to restart after a malfunction or an interruption of power. The number of attempted restarts shall be customer selectable (0 to 5). If the drive reaches the limit of restarts without successfully restarting and running for a customer selectable length of time (60 to 600 seconds), the restart circuit shall lockout and shall provide contact annunciation. Delay between attempts to restart shall be customer selectable from 3 to 300 seconds.
  - 6. Current Limit: A current limit circuit shall be provided to limit motor current to a preset adjustable maximum level by reducing the drive operating speed or acceleration rate when the limit is reached. Range of adjustment shall be from 50 to 110%.
  - 7. Digital Output Displays and Input Parameter Programming: The VFD shall include a digital display and digital input programming capability on the main logic board. The display shall be programmable for indication of output speed in rpm, frequency, and percent of base speed, motor amps, output motor volts, and output load. The display shall also function as a first fault indicator.
  - 8. Critical Frequency Avoidance (Frequency Jump Points): The VFD shall provide selectable frequency jump points to be used to avoid critical resonance frequencies of the mechanical system.
  - 9. Input Signal Follower: The input signal follower circuit shall have selectable differential inputs and accept an electrical speed command from an external source rated at 4-20 mA or 0-10Vdc. The input follower circuit shall be capable of operating directly or inversely proportional to the listed speed commands.
  - 10. Motor Overload Protection: Electronic motor protection shall be provided which is capable of predicting motor winding temperature based on inputting specific parameters including motor design type (TEFC, ODP, or other) and speed range. The protection shall provide an orderly shutdown should the motor's thermal capabilities be exceeded. This protection also eliminates the requirement for motor overload relays on single motor applications when a bypass is not used.
  - 11. Open Collector Outputs: The VFD shall include three (3) open collector outputs to indicate drive run, drive fault, and drive ready.
  - 12. Output Signals: The VFD shall include analog output signals for output load, output speed, instantaneous kw and motor voltage. The signals shall be 4-20 ma or 0-10 Vdc @ 1 mA.
  - 13. Stop Mode Functions: The VFD stopping mode functions shall be selectable for coast-to-rest or stopping at programmed deceleration rate.
  - 14. V/Hz Profiles: The VFD shall provide selectable V/Hz profiles.

15. Loss of Control Signal: The VFD shall revert to the last speed on loss of input control signal. Owner shall be able to field select a preset speed for the VFD to run when control signal is lost, if preferred. In either case, an open collector output shall be selected to indicate loss of control signal for remote indication purposes.
- 
- B. The VFD supplier shall provide the same design/technology to cover the HP range for all VFD's.
  - C. Output Ratings: The VFD shall operate within the following ratings:
    1. Frequency range: 1-120 Hz
    2. Overload rating: 110% for one minute
  - D. Motor Performance: The VFD shall provide 3% speed regulation.
  - E. Input Power: The VFD shall operate within (+5%/-10%) of the nominal rated voltage.
  - F. Set-up Adjustments: Standard setup adjustments shall include:
    1. Minimum speed: 0 to 100%
    2. Maximum speed: 0 to 100%
    3. Linear accel: 0.5 to 600 seconds
    4. Linear decel: 0.5 to 600 seconds
    5. Maximum output voltage: Adjustable
    6. V/Hz: Adjustable with selectable profiles
    7. Current limit: 50 to 110%
  - G. Environmental Ratings: The VFD shall operate within the following parameters without the requirement for derating:
    1. Operating temperature: 0°C to 40°C
    2. Altitude: Up to 1000m (3300 ft.)
    3. Humidity: 95% non-condensing
  - H. Enclosure: Refer to VFD schedule or drawings for enclosure type. At minimum, the enclosure shall be suitable for environment installed. Finned heatsinks and/or cooling fans shall be provided as necessary for proper heat dissipation.
  - I. Protective Features: The VFD shall be designed to meet the following specifications and operate within the following parameters:
    1. AC Input Overcurrent Protection: The VFD's power circuit shall be isolated internally with respect to ground and provided with a 100,000 AIC interrupting rated input circuit breaker. As an alternate to the circuit breaker, fuses may be used to accomplish the 100,000 A interrupting rating.
    2. Logic Common: The power unit's logic common shall be at ground potential.
    3. Phase Loss Protection: Phase loss protection shall be provided to prevent single phasing.
    4. Power Loss Ride-Through: The VFD shall be capable of continued operation during an intermittent loss of power. Opening of the VFD's input and/or output line switches while operating shall not result in damage to the power circuit components.
    5. Short Circuit and Ground Fault Protection: The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. The VFD must be capable of withstanding short circuits at nominal rated voltage plus 10%(i.e., 480V rated drive + 10% = 528V short circuit voltage). The VFD shall be capable of providing 110% motor current intermittently. The VFD shall include an instantaneous overcurrent trip and shall not restart after electronic overcurrent trip until reset through the run/stop circuit, or unless the auto restart function has been enabled.
    6. Transient and Surge Voltage Protection: Transient and surge voltage protection shall be provided through the use of Metal Oxide Varistors (MOVs). The VFD shall withstand a 6000 volt, 80 joule surge voltage when tested in accordance with UL 1449 with the test circuit adjusted for a 2100 amp peak 8x20 us short circuit discharge current pulse.
    7. Rotating Motor Start: The VFD shall be able to start into a motor rotating in either direction and at any speed, and accelerate to set speed without any time delay, tripping or component loss.
    8. DV/DT Filters: Dv/dt filters shall be provided per the VFD schedule, or if recommended by the VFD manufacturer to ensure that the VFD is applied correctly and to maintain the manufacturer's full warranty.
  - J. Maintainability
    1. All control circuit voltages (12VAC, 24VDC, 160VDC and 120VAC) shall be physically and electrically isolated from power circuit voltages (200 to 600VAC, 600VDC) to ensure safety to maintenance personnel.
    2. The VFD shall be furnished with an alphanumeric diagnostic display with fault indications to include the following: bus overvoltage, bus undervoltage, overcurrent, overtemperature, ground fault, and timed overload.

3. VFD shall be capable of starting and operating without a motor connected for ease of service.
4. All setup and operating parameters shall be stored in nonvolatile memory. The static memory module shall be to be removed and installed in replacement logic boards with all setup and operating parameters intact requiring no adjustment of replacement boards.

K. Communications

1. The VFD shall have an RS-485 port as standard. The standard protocols shall be BACnet, Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
2. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the building management system to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The building management system shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The building management system shall also be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.
3. The VFD shall allow the building management system to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the building management system.
4. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

L. Required Optional Features

1. Operator Panel: A door-mounted Softouch Operator Panel shall be included with the following features:
  - a. Shall digitally display motor speed, load, amps, and output volts. (and controller setpoint and system pressure when setpoint controller is included).
  - b. Shall have indication for drive run, drive ready, drive fault, plus operator function/status indication such as auto speed reference, and auto restart.
  - c. Shall provide selection for Hand/Off/Auto control. In Hand mode, the VFD shall be started and stopped from the operator's panel. In the Auto mode, the VFD shall be started and stopped by remote contact closure. In the Off mode, the VFD shall be locked out.
  - d. Shall provide selection for Manual/Auto Speed Reference. In the Manual Reference mode, the VFD speed reference shall be set from the operator's panel. In the Auto Reference mode, the VFD speed reference shall be set by the external source instrument signal. Selecting between Manual and Auto speed reference shall have no bearing on the Hand/Off/Auto start/stop selector, or vice versa.
  - e. Shall name all parameters in English, not codes or numbers.
  - f. Keypad shall include electronic lock-out feature to prevent unauthorized personnel from parameter access.
  - g. Shall store from three to six drive faults in a history batch file in the order they occur to simplify troubleshooting. This file will automatically be updated should new faults occur.
2. Input Overcurrent Protection Device: The operating mechanism shall be designed so that the door can be padlocked in the "OFF" position.
3. Elapsed Time Meter: Meter shall provide indication of how long the drive has been running.
4. Firestat/Freezestat: VFDs for air system fans requiring shutoff from safety devices per sequences of operation shall provide terminals for connecting normally closed remote safety devices. This emergency shutdown shall operate in any mode of operation.



## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Examine areas and conditions under which variable speed drive is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

### **3.2 INSTALLATION**

- A. General: Install systems and materials in accordance with manufacturer's instruction.
- B. Maintain minimum clearance of 12 inches on each side and 36 inches in front of the variable speed drive.
- C. Install variable speed drive in the vertical position.
- D. Provide separate conduits for input and output power cables.
- E. Provide separate conduits for control cables and the output cables to the motor.
- F. Install power and control cabling in separate conduits.
- G. Provide dedicated conduits for power cables to the motors.
- H. Load Side Disconnects: Provide a disconnect switch on the load side of the VFD near the motor for ease of service and safety. Disconnect switch shall be lockable in the open position when the VFD is not within sight of the motor. Operating the switch with the VFD running shall not cause any component failure. In dual motor applications, VFD shall be able to operate either motor with the other motor disconnected without requiring jumpers, parameter modifications, or other adjustments. As part of start-up, VFD supplier shall certify all load side disconnects can be opened or closed with drive running at full speed without damage to the drive.
  - 1. When a separate disconnect is provided at the motor, provide auxiliary contact in the disconnect switch that will shut down the variable speed drive when the disconnect switch is turned off.

### **3.3 START UP**

- A. All units shall be started up at the jobsite by a factory trained and authorized representative.

### **3.4 TRAINING**

- A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.
- B. Content: Training shall include but not be limited to:
  - 1. Overview of the system and/or equipment as it relates to the facility as a whole.
  - 2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
  - 3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."
- C. Certification: Contractor shall submit to the Engineer a certification letter written by the Contractor stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided. Copies of the startup report shall be attached to the certification letter.
- D. Schedule: Schedule training with Owner with at least 14 days' advance notice.

## **END OF SECTION 230514**

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## **SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Flow meters.
- B. Pressure gauges and fittings.
- C. Thermometers and thermometer wells.
- D. Test plugs.

#### **1.2 SUBMITTALS**

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Product Data: Provide schedule that indicates the following for each manufactured component:
  - 1. Model or figure number.
  - 2. Use.
  - 3. Rating.
  - 4. Operating range.
  - 5. Total range.
  - 6. Calibrated performance curves, certified where indicated.
  - 7. Figure number.
  - 8. Location.
  - 9. Accessories.
- C. Product Certificates: Signed by manufacturer certifying accuracy under specified operating conditions and product compliance with specified requirements.
- D. Samples: Submit two of each type of instrument specified.
- E. Project Record Documents: Record actual locations of components and instrumentation.
- F. Operation and Maintenance Data: Furnish data for each manufactured component for inclusion in operating and maintenance manual.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Pressure Gauges: One of each type and size.

#### **1.3 FIELD CONDITIONS**

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

### **PART 2 - PRODUCTS**

- A. Turbine Meter:
  - 1. Manufacturers:
    - a. Badger Meter.
    - b. Onicon Incorporated.
    - c. Spirax Sarco Flow Systems.
    - d. Veris.
  - 2. Meter: Impeller blades designed to pass water containing debris with electrodes to sense blade rotation frequency.

3. Mounting: Insertion or inline. Insertion types shall be complete with "hot-tap" isolation valves to enable sensor removal without water supply system shutdown.
4. Volumetric Accuracy:
  - a. Plus/minus 1 percent of reading over a 10:1 calibrated flow velocity range.
  - b. Plus/minus 2 percent of reading over a 50:1 calibrated flow velocity range.
5. Repeatability: Plus/minus 0.5 percent of reading within the calibrated flow range.

## 2.2 PRESSURE GAUGES

- A. Manufacturers:
  1. Ametek, U.S. Gauge Div.
  2. Ashcroft Dresser Industries Instrument Div.
  3. Dwyer Instruments, Inc.
  4. H.O. Trerice Co.
  5. Marsh Instrument Co., Unit of General Signal.
  6. Marshalltown Instruments, Inc.
  7. Miljoco Corp.
  8. Weiss Instruments, Inc.
  9. Weksler Glass Thermometer Corp.
  10. WIKA Instruments Corp.
  11. Winters Instruments.
- B. Description: ASME B40.100, UL 393, rotary brass movement, white with black markings and black pointer.
- C. Case: Drawn steel, cast aluminum, or stainless steel with phosphor bronze bourdon tube and front or rear recalibration adjustment. Provide silicone fluid damping where required by Part 3.
- D. Size: 4-1/2 inch diameter.
- E. Lens: Clear glass.
- F. Stem: Brass for separable socket, length to suit installation.
- G. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.
- H. Accuracy: Plus or minus 1 percent of range span.
- I. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

## 2.3 PRESSURE GAUGE TAPPINGS

- A. Manufacturers: Same as pressure gauge manufacturers.
- B. Gauge Cock: Tee or lever handle, brass, rated for system pressure.
- C. Needle Valve: Brass, 1/4 inch NPT, rated for system pressure.
- D. Pulsation Damper: Pressure snubber, brass with 1/4 inch threaded connections, corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.
- E. Syphon: Brass, 1/4-inch NPT angle or straight pattern.

## 2.4 STEM TYPE THERMOMETERS

- A. Manufacturers:
  1. Dwyer Instruments, Inc.
  2. H.O. Trerice Co.
  3. Marsh Instruments, Inc.
  4. Miljoco Corp.

5. Weiss Instruments, Inc.
6. Weksler Glass Thermometer Corp.
7. Winters Instruments.

B. Thermometers - Adjustable Angle:

1. Description: Red- or blue-appearing non-toxic liquid in glass tube; ASTM E1.
2. Adjustable Joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
3. Case: Cast aluminum with enamel finish.
4. Size: 9 inch scale.
5. Window: Clear Lexan.
6. Stem: Brass, copper-plated steel, or aluminum for separable socket, length to suit installation.
7. Scale: Progressive, satin-faced, non-reflective aluminum, with permanently etched markings.
8. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.
9. Calibration: Degrees F.

## 2.5 THERMOMETER SUPPORTS

- A. Thermowell Socket: ASTM A536 ductile iron, brass, or stainless steel, compatible with adjacent piping to eliminate dielectric corrosion, with separable socket for thermometer stems and 2 inch extension for insulated piping, pressure rated to match piping system design pressure, with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

## 2.6 TEST PLUGS

- A. Manufacturers:
  1. Flow Design, Inc.
  2. MG Piping Products Co.
  3. Peterson Equipment Co., Inc.
  4. Sisco, A Spedco, Inc. Co.
  5. Watts Regulator.
- B. Test Plug: 1/2 inch nickel-plated brass fitting, rated for 500 psig, extension for insulation, and threaded cap with retention chain for receiving 1/8 inch outside diameter pressure or temperature probe.
- C. Core Material:
  1. Neoprene core for temperatures up to 200 degrees F.
  2. Nordel core for temperatures up to 350 degrees F.
  3. Viton core for temperatures up to 400 degrees F.
- D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauge, one gauge adapter with 1/8 inch probes, two 1 inch bimetal dial thermometers.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install flow meters in a readily accessible location.
- C. Install flow meters with isolating valves on inlet and outlet.
- D. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.

- E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- F. Install thermometers in air duct systems on flanges.
- G. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- H. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- I. Coil and conceal excess capillary on remote element instruments.
- J. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- K. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- L. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- M. Locate test plugs adjacent thermometers and thermometer sockets.

### 3.2 SCHEDULE

- A. Flow Meters: Reference plans for location.
- B. Pressure Gages, Location and Scale Range:
  - 1. Location: Install device at inlet and outlet of each of the following:
    - a. After major coils. Reference details on plans.
  - 2. Scale Range:
    - a. Vacuum: 30 inches Hg to 15 psig.
    - b. All fluids: 2 times operating pressure.
- C. Pressure Gage Tappings, Location:
  - 1. Control valves 3/4 inch & larger – inlets and outlets.
  - 2. Major coils – inlets and outlets.
- D. Stem Type Thermometers, Location and Scale Range:
  - 1. Location: Install device at inlet and outlet of each of the following:
    - a. After major coils. Reference details on plans.
  - 2. Scale Range:
    - a. Hot Water: 30 to 300 degrees F with 2-degree scale divisions
    - b. Chilled Water: 0 to 100 degrees F with 2-degree scale divisions.
- E. Thermometer Sockets, Location:
  - 1. Control valves 1 inch & larger - inlets and outlets.
  - 2. Reheat coils - inlets and outlets.

**END OF SECTION 230519**

## **SECTION 230523 - GENERAL DUTY VALVES FOR HVAC PIPING**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Applications.
  - 1. General duty valves common to most mechanical piping systems.
  - 2. Special purpose valves are specified in individual piping system specifications.
- B. General requirements.
- C. Ball valves.
- D. Butterfly valves.
- E. Check valves.
- F. Chainwheels.

#### **1.2 ABBREVIATIONS AND ACRONYMS**

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

#### **1.3 SUBMITTALS**

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, pressure and temperature classifications, valve design, body material, seating materials, trim material, dimensions, clearances, rough-in details, weights, support requirements, and piping connections.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer:
  - 1. Obtain valves for each valve type from a single manufacturer.
  - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
  - 3. Subject to compliance requirements, provide products from one of the manufacturers listed in Valve Schedule in Part 3.
- B. Valves shall be certified to meet the specified ASTM, ASME, ANSI, and MSS standards in Part 2 Products, and as follows:
  - 1. ASME B31.9 for building services piping.
  - 2. ASME B31.1 for power piping.
- C. Welding Materials and Procedures: Conform to ASME BPVC-IX.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
  - 2. Protect valve parts exposed to piped medium against rust and corrosion.
  - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
  - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
  - 5. Secure check valves in either the closed position or open position.
  - 6. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection and protect flanges and specialties from dirt.
    - a. Provide temporary inlet and outlet caps.
    - b. Maintain caps in place until installation.
  - 2. Store valves in shipping containers and maintain in place until installation.
    - a. Store valves indoors in dry environment.
    - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
- C. Exercise the following precautions for handling:
  - 1. Avoid the use of operating handles or stems as rigging or lifting points.

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products from one of the manufacturers listed in the Valve Schedule in Part 3.

#### 2.2 APPLICATIONS

- A. Provide the following valves for the applications if not indicated on Drawings:
  - 1. Isolation (Hydronic): Butterfly, and Ball.
  - 2. Dead-End: Butterfly and Ball.
- B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.
- C. Required Valve End Connections for Non-Wafer Types:
  - 1. Steel Pipe:
    - a. 2 NPS and Smaller: Threaded ends.
    - b. 2-1/2 NPS and Larger: Grooved or flanged ends.
  - 2. Copper Tube:
    - a. 2 NPS and Smaller: Threaded or solder-joint valve ends.



- b. 2-1/2 NPS and Larger: Grooved or flanged ends.
- D. Chilled Water Valves:
  - 1. 2 NPS and Smaller:
    - a. Minimum Class: 125.
    - b. Body: Bronze.
    - c. Allowable Valve Types:
      - 1) Ball: Two piece. Forged brass body is acceptable to bronze body.
        - a) Brass components.
      - 2) Swing check.
  - 2. 2-1/2 NPS and Larger:
    - a. Minimum Class: 125.
    - b. Body: Cast iron, except as noted below.
    - c. Allowable Valve Types:
      - 1) Ball: 2-1/2 inch to 3 inch: Three piece, bronze, forged brass, carbon steel, or stainless steel body.
        - a) Brass components.
      - 2) Butterfly: Ductile iron body.
      - 3) Lift check.
      - 4) Swing check.
- E. Heating Hot Water Valves:
  - 1. 2 NPS and Smaller:
    - a. Minimum Class: 125.
    - b. Body: Bronze.
    - c. Allowable Valve Types:
      - 1) Ball: Two piece. Forged brass body is acceptable to bronze body.
        - a) Brass components.
        - b) Stainless steel components.
      - 2) Lift check.
      - 3) Swing check.
      - 4) Wafer plate-type check.
      - 5) Gate.
      - 6) Globe.
    - 2. 2-1/2 NPS and Larger:
      - a. Minimum Class: 125.
      - b. Body: Cast iron, except as noted below.
      - c. Allowable Valve Types:
        - 1) Ball: 2-1/2 inch to 3 inch: Three piece, bronze, forged brass, carbon steel, or stainless steel body.
          - a) Brass components.
          - b) Stainless steel components.
        - 2) Butterfly: Ductile iron body.
        - 3) Lift check.
        - 4) Swing check.
        - 5) Wafer plate-type check.
        - 6) Gate.
        - 7) Globe.

## 2.3 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Stem Design:
  - 1. Rising stem or rising outside screw and yoke stems.
  - 2. Non-rising stem valves may be used on water systems where headroom prevents full extension of rising stems.

- D. Valve Actuator Types:
  - 1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
  - 2. Handwheels: Valves other than quarter-turn types.
  - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller, vinyl-covered.
  - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: Provide stem extensions so valve operator extends a minimum of 1/2 inches outside of the insulation and the following features:
  - 1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 2. Butterfly Valves: Extended neck.
  - 3. Memory Stops: Fully adjustable after insulation is installed.
- F. Valve-End Connections:
  - 1. Threaded End Valves: ASME B1.20.1.
  - 2. Flanges: ASME B16.1 for cast iron.
  - 3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5 for steel, ASME B16.24 for bronze.
  - 4. Solder Joint Connections: ANSI B16.18.
  - 5. Grooved End Connections: AWWA C606.
- G. General ASME Compliance:
  - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
  - 2. Power Piping Valves: ASME B31.1.
  - 3. Building Services Piping Valves: ASME B31.9.
- H. Bronze Valves:
  - 1. Fabricate from dezincification resistant material.
  - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- I. Valve Bypass and Drain Connections: MSS SP-45.
- J. Source Limitations: Obtain each valve type from a single manufacturer.

## 2.4 BRONZE BALL VALVES

- A. Two Piece, Class 150, bronze trim, for valves 2 inch and smaller:
  - 1. Comply with MSS SP-110.
  - 2. CWP Rating: 600 psi.
  - 3. Body: Bronze, ASTM B584.
  - 4. Trim: Bronze.
  - 5. Ends: Threaded or solder joint.
  - 6. Seats and Seals: PTFE.
  - 7. Stem: Blowout-proof.
  - 8. Ball: Full port, chrome plated brass.
  - 9. Operator: Vinyl-covered steel handle.
- B. Three Piece, Class 150, bronze trim, for valves 2-1/2 inch to 3 inch:
  - 1. Comply with MSS SP-110.
  - 2. CWP Rating: 600 psig.
  - 3. Body: Bronze, ASTM B584.
  - 4. Trim: Bronze.
  - 5. Ends: Threaded or solder joint.
  - 6. Seats and Seals: PTFE.
  - 7. Stem: Blowout-proof.
  - 8. Ball: Full port, chrome plated brass.
  - 9. Operator: Vinyl-covered steel handle.

## 2.5 BRASS BALL VALVES

- A. Two Piece, Class 150, brass trim, for valves 2 inch and smaller:
  - 1. Standard: MSS SP-110.
  - 2. CWP Rating: 600 psig.
  - 3. Body Design: Two piece.
  - 4. Body Material: Forged brass, ASTM B283 or DZR forged brass, ASTM B283 UNS No. C48640.
  - 5. Trim: Brass.
  - 6. Ends: Threaded or soldered.
  - 7. Seats: PTFE.
  - 8. Stem: Blowout-proof ,brass.
  - 9. Ball: Chrome plated brass.
  - 10. Port: Full.
- B. Two Piece, Class 150, Brass Trim, for valves 2-1/2 inch to 3 inch:
  - 1. Standard: MSS SP-110.
  - 2. CWP Rating: 600 psig.
  - 3. Body Design: Three piece.
  - 4. Body Material: Forged brass, ASTM B283 or DZR forged brass, ASTM B283 UNS No. C48640.
  - 5. Trim: Brass.
  - 6. Ends: Threaded or soldered ends.
  - 7. Seats: PTFE.
  - 8. Stem: Blowout-proof, brass.
  - 9. Ball: Chrome plated brass.
  - 10. Port: Full

## 2.6 CARBON STEEL BALL VALVES

- A. Two Piece, Class 150:
  - 1. Comply with MSS SP-72.
  - 2. CWP Rating: Minimum 1,000 psig.
  - 3. Construction: Two-piece or three-piece.
  - 4. Body: Carbon steel, ASTM A216/A216M, Type WCB.
  - 5. Trim: Stainless steel.
  - 6. Ends: Threaded.
  - 7. Seats and Seals: PTFE.
  - 8. Stem: Stainless steel, blowout-proof.
  - 9. Ball: Full port, stainless steel, vented.
  - 10. Operator: Vinyl-covered steel handle.

## 2.7 BRONZE SWING CHECK VALVES

- A. Class 125:
  - 1. Comply with MSS SP-80, Type 3.
  - 2. CWP Rating: 200 psig.
  - 3. Design: Horizontal swing, Y-pattern, capable of being refitted and ground while valve remains in the line.
  - 4. Body: Bronze, ASTM B62.
  - 5. Ends: Threaded or solder joint.
  - 6. Disc: PTFE.

## 2.8 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125, 200 psig CWP.
  - 1. Comply with MSS SP-71, Type I.
  - 2. Design: Horizontal swing, clear or full waterway, capable of being refitted and ground while valve remains in the line.
  - 3. Body: Cast iron with bolted bonnet in accordance with ASTM A126, Class B.
  - 4. Ends: Flanged.
  - 5. Trim: Bronze.

6. Disc Holder: Bronze face ring and seat ring.
7. Disc: Bronze or ductile iron.
8. Gasket: Asbestos free.

## 2.9 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
  1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
  2. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
  3. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. If valve is determined to be defective, replace with new valve.

### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Locate valves for easy access. Provide access doors and fire rated access doors as required.
- C. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- D. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
- E. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.
- F. Install three-valve bypass around each pressure reducing valve using throttling-type valves.
- G. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- H. Install valves in a position to allow full stem movement.
- I. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- J. Valves with soldered end connections:
  1. Use solder with a melting point as follows:
    - a. Below 840 degrees F for check valves.
    - b. Below 421 degrees F for ball valves.
- K. Install check valves where necessary to maintain direction of flow as follows:
  1. Swing Check: Install horizontal maintaining hinge pin level.
  2. Orient plate-type into horizontal or vertical position, between flanges.

- L. Provide chainwheels on operators for valves 2-1/2 NPS and larger where located 72 inches or more above finished floor in mechanical rooms, terminating 60 NPS above finished floor.

### 3.3 FIELD QUALITY CONTROL

- A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leak; replace valves if leak persists.

### 3.4 ADJUSTING AND CLEANING

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

### 3.5 VALVE SCHEDULE

- A. Bronze Globe Valves, Class 125:

Manufacturer	Threaded <u>NRS</u>	Threaded <u>RS</u>	Solder <u>RS</u>
Apollo	--	120T	120S
Crane	--	5TF	--
Nibco	--	T-211-Y	S-211-Y
Stockham	B-13T	--	B-14T

- B. Bronze Globe Valves, Class 150:

Manufacturer	Threaded <u>NRS</u>	Threaded <u>RS</u>	Solder <u>RS</u>
Apollo	--	122T	--
Crane	--	7TF	1310
Hammond	--	IB413T	IB423
Jenkins	--	106BJ	--
Milwaukee	--	590T	1590T
Nibco	--	T-235-Y	S-235-Y
Powell	150	--	--
Stockham	--	B-22T	--

- C. Bronze Ball Valves – 2 inch and smaller, Class 150:

1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

<u>Manufacturer</u>	<u>Threaded Ends</u>	<u>Solder Ends</u>
Apollo	77C-140	77C-240
Hammond	8301A	8311A
Milwaukee	BA-400	BA-450
Nibco	T-585-70	S-585-70
Watts	LFB6080G2	LFB6081G2

- D. Bronze Ball Valves - 2-1/2 inch to 3 inch, Class 150:

1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

<u>Manufacturer</u>	<u>Threaded Ends</u>	<u>Solder Ends</u>
Apollo	82-100	82-200
Hammond	8604	8614
Milwaukee	BA-300	BA-350
Nibco	T-595-Y	S-595-Y
Watts	LFB6080G2	LFB6081G2

- E. Brass Ball Valves – 2 inch and smaller, Class 150:  
 1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

<u>Manufacturer</u>	<u>Threaded Ends</u>	<u>Solder Ends</u>
Apollo	77F-100	77F-200
Bray	S51	
Hammond	8901	8911
Kitz Corporation	AKTFLL	CTFLL
Milwaukee	BA-475B	BA-485B
Nexus Valve Inc.	UX-#F-#F	UX-#S-#S
Nibco	T-FP-600A	S-FP-600A
Watts	FBV-3C	FBVS-3C

- F. Brass Ball Valves - 2-1/2 inch to 3 inch, Class 150:  
 1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

<u>Manufacturer</u>	<u>Threaded Ends</u>	<u>Solder Ends</u>
Hammond	8901	8911
Kitz Corporation	AKTAFP	--
Milwaukee	BA-475B	BA-485B
Nexus Valve Inc.	UX-#F-#F	UX-#S-#S
Nibco	T-595-Y	S-595-Y

- G. Iron Butterfly Valves, 200 psig CWP:

<u>Manufacturer</u>	<u>Series</u>
Apollo	LD141
Bray	30/31
Crane Center Line	44
Keystone	222
Nibco	LD-2000
Stockham	LD-712 & 722
Watts	BF-03
Milwaukee	ML
Hammond	6411

- H. Bronze Swing Check Valves:

<u>Manufacturer</u>	<u>Class 125</u> <u>Threaded</u>	<u>Class 125</u> <u>Solder</u>	<u>Class 150</u> <u>Threaded</u>	<u>Class 200</u> <u>Threaded</u>
Apollo	163T	163S	164T	169T
Crane	41TF	--	141TF	36
Hammond	IB940	--	IB946	IB944
Jenkins	4037J	--	4475TJ	4449J
Milwaukee	509-T	1509-T	510-T	508
Nibco	T-413-Y	S-413-Y	T-433-Y	T-453-B
Powell	578	--	--	560Y
Stockham	B-320-T	B-310-T	B322	B-345

**END OF SECTION 230523**

## **SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Support and attachment components.
- B. Horizontal piping hangers and supports.
- C. Saddles and shields.
- D. Vertical piping clamps.
- E. Anchors and fasteners.
- F. Miscellaneous materials.

#### **1.2 ADMINISTRATIVE REQUIREMENTS**

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

#### **1.3 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.
- B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.
- C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."
- E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.
  - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- F. Installer's Qualifications: Include evidence of compliance with specified requirements.
- G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

## 1.4 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Field-Welding:
  - 1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
  - 2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
  - 3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."
- D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

## 1.5 DELIVERY, STORAGE, AND HANDLING

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

## **PART 2 - PRODUCTS AND MATERIALS**

### 1.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
  - 1. Comply with MSS SP-58.
  - 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
  - 3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  - 6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Provide painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.
    - a. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
    - b. Natatorium or other treated pool environments: Type 316 stainless steel.
    - b. Outdoor Locations: Galvanized steel or Type 304 stainless steel.
    - c. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
    - d. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - e. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
    - f. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.
- B. Metal Channel (Strut) Framing Systems:
  - 1. Manufacturers:
    - a. Cooper B-Line.
    - b. Ferguson Enterprises/FNW.
    - c. PHD Manufacturing.
    - d. Thomas & Betts Corporation.
    - e. Unistrut, a brand of Atkore International Inc.



- f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
  2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
  3. Comply with MSS SP-58, Type 59, MSS SP-89, and MFMA-4. Welds shall comply with AWS D1.1.
  4. Channel Material:
    - a. Indoor Dry Locations: Provide carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.
    - b. Indoor Damp or Wet Locations: Galvanized steel or Type 304 stainless steel.
    - c. Outdoor Locations: Galvanized steel or Type 304 stainless steel.
    - d. Natatorium or other treated pool environments: Type 316 stainless steel.
    - e. All nuts, brackets, and clamps shall have the same finish as the channel.
  5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.
  6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.
  7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.
- C. Hanger Rods:
1. Material:
    - a. Indoor Dry Locations: Zinc-plated steel.
    - b. Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or type 304 stainless steel.
    - c. Natatorium or other treated pool environments: Type 316 stainless steel.
  2. Threaded both ends or continuously threaded.
  3. Minimum Size: Reference piping specification sections for rod thicknesses.
  4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.
- D. Wire Rope Pipe Hanging Systems:
1. Manufacturers:
    - a. ASC Engineered Solutions.
    - b. Gripple.
  2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
  3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
  4. Cast-in-place Concrete Insert: Pressed steel body with sintered steel wedge, 302 stainless steel spring and UV stabilized homopolymer polypropylene end cap. Model: Gripple Spider Hanging Kit.
  5. Cable Stud: Carbon steel, zinc-coated, designed for attachment to concrete inserts. Model: ASC Engineered Solutions C120.
  6. Cable Coupling: Carbon steel, zinc-coated, designed for attachment to threaded rods. Model: ASC Engineered Solutions C130.
  7. Cable Eyelet: Carbon steel, zinc-coated, designed to be directly attached to structural supports via anchors or fasteners. Model: ASC Engineered Solutions C150.
  8. Cable Toggle: Carbon steel, zinc-coated, with toggle designed for insertion into 1/2 inch hole through steel deck hat channel and provides anchor when pulled in tension. Model: ASC Engineered Solutions C160.
  9. Swivel Toggle Insert: Single assembly attached to wire rope cable, manufactured from plated carbon steel toggle, pins, and shackles; swivel insert engineered to be compatible with concrete insert.
  10. Wire Rope: High tensile steel wire rope, to ASTM A1023, Class A zinc coating; minimum 7 by 7 cross-sectional thread construction; having a tensile strength of 256,000 psi; No.3 wire size minimum.
  11. Adjustable Fastener: Mild steel (type UG2), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 500 lb. Model: Gripple No. 2, 3 or 4 UniGrip.

## 2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Manufacturers:
1. Armacell.
  2. ASC Engineered Solutions.
  3. Cooper B-Line, Inc.
  4. Elite Components.
  5. ERICO/Michigan Hanger Co./Caddy
  6. Ferguson/FNW.

7. Halfen-DEHA.
  8. Hilti.
  9. National Pipe Hanger Corporation.
  10. PHD Manufacturing.
  11. Piping Technology and Products, Inc.
  12. Power-Strut.
  13. Unistrut.
- B. Single Hangers:
1. Band Hanger: Carbon steel, adjustable band, adjustable swivel.
  2. Split Ring: Carbon steel, adjustable swivel, split ring type.
  3. Clevis Hanger: Carbon steel, adjustable, clevis type.
  4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.
- C. Trapeze and Strut-mounted Supports:
1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
  2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.
- D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:
1. Manufacturers:
    - a. ASC Engineered Solutions.
    - b. Holdrite.
    - c. Klo-Shure.
  2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.
- E. Spring Hangers:
1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for spring isolation hangers.
- F. Wall Supports:
1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.
  2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.
- G. Floor Supports:
1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- H. Pre-Insulated Supports:
1. Manufacturers:
    - a. Aeroflex USA, Inc.
    - b. Armacell.
    - c. ASC Engineered Solutions
    - d. Buckaroos, Inc.
    - e. Cooper B-Line, Inc.
    - f. Pipe Shields, Inc.
  2. General Construction and Requirements:
    - a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.
    - b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
    - c. Waterproof calcium silicate insulation shall conform to ASTM C795.
    - d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.
    - e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.
  3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

## 2.3 SADDLES AND SHIELDS

- A. Pipe Covering Protection Saddles:
1. Manufacturers: Same as hanger and Supports.
  2. Meet MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12 inches and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12 inches long.
- B. Insulation Protection Shield:
1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.
  2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
  3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
  4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in)					
		Hanger Spacing, (ft)					
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
≤ 2	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

- C. 360 Degree Insulation Protection Shield:
1. Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
- D. Plastic Saddles and Shields:
1. Manufacturers:
    - a. Armacell.
    - b. Eaton.
    - c. Hydra-Zorb.
    - d. PHD Manufacturing.
    - e. Zsi Foster.
  2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

## 2.4 VERTICAL-PIPING SUPPORTS

- A. Manufacturers:
1. ASC Engineered Solutions.
  2. Cooper B-Line, Inc.
  3. Halfen-DEHA.
  4. Hilti.
  5. ERICO/Michigan Hanger Co.
  6. National Pipe Hanger Corporation.
  7. PHD Manufacturing.
  8. Piping Technology and Products, Inc.
  9. Power-Strut.
  10. Unistrut.
- B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.

2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
  3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.
- C. Riser Clamps with pre-manufactured polymer insert:
1. Manufacturers:
    - a. Hydra-Zorb; Titan Riser Clamp.
    - b. National Pipe Hanger.
    - c. Pipe Hangers, Inc.
  2. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

## 2.5 ANCHORS AND FASTENERS

- A. Manufacturers:
1. Hilti, Inc.
  2. Illinois Tool Works, Inc.
  3. Phillips.
  4. Powers Fasteners, Inc.
  5. Rawl.
  6. Simpson Strong-Tie Company Inc.
- B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
1. Concrete: Use preset concrete inserts or expansion anchors.
  2. Solid or Grout-Filled Masonry: Use expansion anchors.
  3. Hollow Masonry: Use toggle bolts.
  4. Hollow Stud Walls: Use toggle bolts.
  5. Steel: Use beam clamps.
  6. Sheet Metal: Use sheet metal screws.
  7. Wood: Use wood screws.
  8. Plastic and lead anchors are not permitted.
  9. Hammer-driven anchors and fasteners are permitted only as follows:
    - a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
    - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.
- C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
1. Comply with MFMA-4.
  2. Channel Material: Use galvanized steel.
  3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
  4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rod dimensions.
  5. Manufacturers:
    - a. Same as manufacturer of metal channel (strut) framing system.
    - b. DeWalt "Bang-It" concrete inserts.
- D. Post-Installed Concrete and Masonry Expansion Anchors:
1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
  2. Self-drilling drilled flush or shell type. Size inserts to suit threaded rods.
- E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.
1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
  1. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- F. Vibration Isolation Anchors: Reference Section "Vibration Isolation for HVAC Piping and Equipment" for vibration isolation anchors.

## 2.6 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Malleable Iron: ASTM A47
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

## **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, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- I. Provide vibration isolators at hangers and supports where specified in Section "Vibration Isolation for HVAC".

### 3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.
- B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- C. Space attachments within maximum piping span length specified in Division 23 piping sections.
- D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- E. Install hangers, supports, clamps and attachments to support piping properly from building structure.
- F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

- G. Hanger and clamps sizing:
  - 1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
  - 2. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
  - 3. Refer to Section "HVAC Insulation" for definition of hot and cold piping and required insulation thickness.
- H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 23 piping sections.
  - 1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
  - 2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
    - a. Uninsulated Copper Pipe: Install with plastic galvanic isolators
    - b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Section "HVAC Insulation".
- I. Install building attachments within concrete or to structural steel.
  - 1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.
  - 2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.
- K. Install appropriate types of hangers and supports to allow controlled 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.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
  - 1. Riser Clamps: Attach riser clamp to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 23 Section "HVAC Insulation".
    - a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert.
  - 2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
    - a. If insulation protection shields are used instead of protection saddles on hot piping where vapor barrier is not required, provide high density insulation insert sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation".
  - 3. Insulation Protection Shield: Install insulation protection shield with high density insulation insert, sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation". Do not use polymer-based shields for hot piping.
    - a. Exception for 2 inch and smaller horizontal piping with cellular glass, flexible elastomeric, or polyisocyanurate insulation: High density insulation insert is not required. Provide insulation protection shield over the insulation with length specified for pipe size and insulation thickness to prevent puncture or other damage.
  - 4. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.
  - 5. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
- O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
  - 1. Uninsulated Copper Pipe: Install with plastic galvanic isolators

2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section "HVAC Insulation".

P. Vertical Piping Risers:

1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for piping riser supports.

Q. Wire Rope Hanging Systems:

1. Install in accordance with manufacturer's instructions.
2. Supported load shall not exceed manufacturer's recommended load rating.
3. Applications for Pipe Supports:
  - a. 3 inch and smaller.
  - b. Wire rope hanging system is not allowed for steam or steam condensate piping.
4. Do not support pipe by wrapping the rope around the pipe.
5. Provide appropriate hanger or support compatible with the wire rope hanging system adjustable fastener as specified in the Pipe Hanger and Support Schedule.
6. Install cast-in-place concrete inserts in elevated concrete slabs.
7. Install bream clamps for attachment to structural beams as required.

### 3.4 INSTALLATION OF ROOF EQUIPMENT SUPPORTS

- A. Attach roof equipment support to the roof structure according to the manufacturer's installation instructions.
- B. Provide multiple single rail equipment supports to uniformly support the equipment.
- C. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope.
- D. Install supports to maintain continuous insulation on roof.
- E. Provide vibration isolators between roof equipment support and equipment according to Division 23 Section "Vibration Isolation for HVAC."

### 3.5 EQUIPMENT SUPPORT AND ATTACHMENT

- A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
- B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.
- C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
- D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
  1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.
- F. Secure fasteners according to manufacturer's recommended torque settings.
- G. Remove temporary supports.
- H. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.
- I. Grouting: Place grout under supports for piping and equipment.

### 3.6 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

- 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 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

### 3.7 FIELD QUALITY CONTROL

- A. Examine support and attachment components for damage and defects.
- B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."
  - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.
- F. Correct deficiencies and replace damaged or defective support and attachment components.

### 3.8 PIPE HANGER AND SUPPORT SCHEDULE

- A. Additional hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:
- C. Single Hangers:
  - 1. All pipe sizes 1-1/2 inch and less:
    - a. Band hanger.
    - b. Swivel split ring.
    - c. Clevis hanger.
  - 2. Cold and Hot pipe sizes 2 inches and greater where pipes are in stationary position: Clevis hanger.
  - 3. Cold and Hot pipe sizes 2 inches and greater for pipes in the following locations: Roll support hanger.
    - a. Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.
    - b. Between anchor locations shown on the drawings.
- D. Trapezes and Strut-mounted Supports:
  - 1. Pipes in stationary position: Two-piece clamp, strut clamp or U-bolts.
  - 2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.
    - a. Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.
    - b. Between anchor locations shown on the drawings.
- E. Wall Supports:
  - 1. Pipe sizes 3 inches and less:
    - a. Two-hole strap mounted to wall.
    - b. Welded steel bracket with reinforced angle or strut.
  - 2. Pipe sizes 4 inch and greater:
    - a. U-bolt.



- b. Welded steel bracket with reinforced angle or strut.
- F. Floor Supports:
  - 1. Pipes in stationary position: Pipe saddle.
  - 2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.
    - a. Axial movement due to thermal expansion or contraction is greater than one inch.
    - b. Between anchor locations shown on the drawings.

**END OF SECTION 230529**

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## **SECTION 230550 - VIBRATION ISOLATION FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Vibration isolation requirements.
- B. Vibration-isolated equipment support bases.
- C. Vibration isolators.

#### **1.2 COORDINATION**

- A. Contractor's Responsibility:
  - 1. Verify the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.
  - 2. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.
  - 3. Coordinate selection and arrangement of vibration isolation components with the actual equipment to be installed.
  - 4. Coordinate the work with other trades to provide additional framing and materials required for installation.
  - 5. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
  - 6. Sequencing:
    - a. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.
- B. Manufacturer's Responsibility:
  - 1. Determine vibration isolation types for all equipment and systems in accordance with the local governing code.
  - 2. Calculate the static deflection requirements for all equipment and systems to provide uniform deflection based on distributed operating weight of actual installed equipment.
  - 3. Select the vibration isolation systems to provide static deflection indicated on the Vibration Isolation Schedule and as specified below. Determine the mounting sizes and layout.
  - 4. Guarantee specified isolation system deflection.
  - 5. Select and size vibration isolators to not exceed the recommended loading of the isolators.
  - 6. Provide installation instructions, drawings and field supervision to ensure proper installation and performance.
  - 7. Verify that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators.

#### **1.3 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
  - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities. Include clearly outlined procedures for installing and adjusting the isolators.
- B. Shop Drawings:
  - 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators on each piece of isolated equipment. Indicate equipment weights and static deflections.
  - 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable. Indicate equipment mounting provisions.
  - 3. Piping isolators shown and identified on piping layout drawings.
  - 4. Concrete foundations, supports, and required reinforcing and forms. These appurtenances shall be provided by another trade. This trade shall furnish the shop drawings, including the following:
    - a. Concrete reinforcing steel details and templates for all foundations and supports.

- b. Required hanger bolts.
  - c. All other appurtenances necessary for proper installation of equipment.
- C. Vibration Isolation System Schedule: Include the following for each isolation element:
  - 1. Manufacturer, isolator type, model number, size.
  - 2. Height when uncompressed and static deflection.
  - 3. Spring constant.
  - 4. Spring outside diameter, free operating, and solid heights.
  - 5. Design of supplementary bases.
  - 6. Details of attachment to load-bearing structure or supplementary framing.
- D. Post-Installation Inspection Report:
  - 1. Vibration isolation vendor notice of inspection of all vibration isolators.
  - 2. Vibration isolation vendor notice of approval that all vibration isolators have been properly installed and conform to the specification.
  - 3. Itemized list of deficiencies.
  - 4. Vibration Isolation System Schedule.
  - 5. For each isolator containing steel springs, record the following:
    - a. Size.
    - b. Uncompressed height.
    - c. Design static deflection.
    - d. Measured static deflection.

#### 1.4 QUALITY ASSURANCE

- A. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.
- B. All vibration isolation equipment and materials shall be new and manufactured specifically for the purpose intended.
- C. Maintain at the project site a copy of each reference document that prescribes execution requirements.
- D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

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

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 MANUFACTURERS

- A. Caldyn, California Dynamics Corp.
- B. Kinetics Noise Control.
- C. Mason Industries, Inc.
- D. Vibration Eliminator Co., Inc.
- E. Vibration Mounting and Controls.
- F. Vibro-Acoustics.

#### 2.2 VIBRATION ISOLATION REQUIREMENTS

- A. Construct vibration isolators out of resilient materials resistant to oil, ozone, and oxidant.

- B. Select vibration isolators to provide the static deflection as specified in Part 2 "Products" unless otherwise specified for the application listed in Part 3 "Execution."
- C. Where a pipe run connects multiple equipment, select the pipe isolators for the entire run to suit the connected equipment of greatest static deflection.
- D. Vibration isolators shall have either known undeflected heights or calibration markings so that the amount of deflection can be verified after adjustment to determine that the load is within the proper range of the device and that the correct degree of vibration isolation is provided according to the design.
- E. Vibration isolators, base frames, and inertia bases shall provide uniform deflection and stability under all operating loads.
- F. Isolators for fans shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.
- G. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.
- H. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than plus/minus 10 percent.
- I. All elastomeric mountings shall have a Shore hardness of 30 to 60 plus/minus 5 after minimum aging of 20 days or corresponding over-aging, or as specified herein.
- J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated of natural rubber instead of neoprene.
- K. Equipment mounted on vibration isolated bases shall have minimum operating clearance of 1 inch between the base and floor or support beneath unless noted otherwise.
- L. Vibration Isolator Assemblies with Steel Springs:
  - 1. Housed or caged spring isolators are not acceptable.
  - 2. Assemblies shall use bare springs, color coded or otherwise identify springs to indicate load capacity.
  - 3. Spring diameter shall not be less than 0.8 of the loaded operating height of the spring.
  - 4. The ratio of the horizontal to vertical spring constant shall be between 1 and 2.
  - 5. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
  - 6. Assembly shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation.
  - 7. Springs shall operate in the linear portion of their load versus deflection curve over a deflection range of not less than 50 percent above the design deflection.
- M. Vibration isolators exposed to weather and other corrosive environments shall be protected with factory corrosion resistance.
  - 1. Exterior applications:
    - a. Springs: Cadmium-plated and neoprene coated.
    - b. Nuts and bolts: Cadmium plated.
    - c. Other metal mounting parts: Hot-dip galvanized.
  - 2. Interior applications: Painted.

## 2.3 VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

- A. Pre-Engineered Roof Equipment Support (Type RES):
  - 1. Reference Section "Hangers and Supports for HVAC Piping and Equipment" for specification of non-vibration isolated, pre-engineered roof equipment supports.
- B. Structural Rails (Type SR):
  - 1. Assembly: Structural steel channels furnished with double-deflection neoprene mountings or spring isolators.
  - 2. Base: All metal mounting parts shall be covered with neoprene to avoid corrosion and metal-to-metal contact.
  - 3. Selection: Channel length and isolator type with deflection as required for proper isolation of equipment.
  - 4. Type SR: Mason Industries Type RND or approved equal.

- C. Concrete Inertia Base (Type CIB):
1. Description: Engineered steel forms into which concrete is poured, with integrated motor slide base, isolator brackets and anchor bolts, welded or tied reinforcing bars running both ways in a single layer. Where anchor bolt locations fall in concrete, reinforcing steel forms shall include drilled members with sleeves welded below the steel to accept bolts. Height saving steel brackets shall be used in all mounting locations.
  2. Size: Beam depth equal to 10 percent of the longest span of the base, 6 inches minimum but not more than 12 inches. Size to accommodate incoming pipe suction diffuser or elbow supports.
  3. Mass: Minimum of 1.5 times weight of isolated equipment.
  4. When the concrete base is "T" shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.
  5. The structural perimeter frame, mounting templates, height saving brackets, and spring system shall be provided as an assembly by the vibration control vendor.
  6. Type CIB: Mason Industries Type KSL or approved equal.

## 2.4 VIBRATION ISOLATORS

- A. Ribbed Neoprene "Waffle" Pads (Type WP):
1. Assembly: Single ribbed or crossed double ribbed elastomer in-shear pads, in one or more layers separated and bonded to a minimum 1/4 inch thick galvanized steel shim plate as required to provide selected deflection.
  2. Thickness: Each layer 5/16 inch thick.
  3. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.05 inches.
  4. Type WP: Mason Industries Type W, Type WSW, or approved equal.
- B. Steel Spring Neoprene Mounts (Type SPNM):
1. Assembly: Single or multiple free-standing and laterally stable steel springs without a housing.
    - a. Light capacity base: Molded elastomeric neoprene load plate.
    - b. Heavy capacity base: Springs welded to the load plate assembly furnished with integral elastomeric pad.
    - c. Leveling Device: Rigidly connected to equipment or frame.
  2. Selection:
    - a. Minimum static deflection for equipment mounted on grade slabs shall be 1 inch unless specified otherwise.
    - b. Minimum static deflection for equipment mounted above grade (suspended) slabs shall be 2 inches unless specified otherwise.
  3. Type SPNM: Mason Industries Type SLFH or approved equal.
- C. Double Deflection Neoprene Hangers (Type DDNH)
1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator. Neoprene isolator shall prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function.
    - a. Housing: Bottom opening sized to allow hanger rod to swing through a 30 degree arc.
  2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches.
  3. Type DDNH: Mason Industries Type HD or approved equal.
- D. Spring and Neoprene Hanger (Type SPNH)
1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator in series with a steel spring.
    - a. Housing: Include a neoprene bushing to prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function. Bottom opening sized to allow hanger rod to swing through a 30 degree arc.
  2. Selection:
    - a. Neoprene isolator: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.
    - b. Spring isolator: Minimum static deflection of 2 inches unless specified otherwise.
  3. Type SPNH: Mason Industries Type 30N or approved equal.
- E. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.
- F. Flexible Connectors:
1. Pipe: Refer to Section "Hydronic Piping Specialties."
  2. Duct: Refer to Section "Air Duct Accessories."

- G. Pipe Riser Anchor (Type PRA)
  - 1. Assembly: Telescoping arrangement of two sizes of steel tubing separated by minimum 1/2 inch thick, 60 durometer neoprene. Anchor shall include tapped hole on the top plate for bolt attachment to riser clamp. Anchor shall allow for all-directional movement.
  - 2. Selection: Static deflection of 0.1 inches, maximum allowable load on the isolation material shall not exceed 500 psi.
  - 3. Type PRA: Mason Industries Type ADAH or approved equal.
- H. Pipe Riser Guide (Type PRG):
  - 1. Assembly: Telescoping arrangement of two sizes of steel tubing separated by minimum 1/2 inch thick, 60 durometer neoprene with set screw to prevent lateral movement. Guide shall include tapped hole on the top plate for bolt attachment to riser clamp.
  - 2. Type PRG: Mason Industries Type VSGH or approved equal.
- I. Riser Suspension Anchor (Type PRSA):
  - 1. Assembly: Steel hanger box containing laterally stable steel spring with integral deflection scale, adjustment plate, and nut. Housing shall include tapped hole at the top for hanger rod attachment.
  - 2. Selection: Minimum static deflection of 4 inches.
  - 3. Type PRSA: Mason Industries Type HES or approved equal.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that mounting surfaces are ready to receive vibration isolation and associated attachments.

#### **3.2 INSTALLATION - GENERAL**

- A. Install in accordance with manufacturer's instructions.
- B. External spring isolators are not required if unit is provided with internal spring isolation. If external spring isolators are provided, internal spring isolation shall not be approved.
- C. Mount or suspend all equipment, piping, ductwork, etc. from approved foundations and supports as specified herein or as shown on the drawings.
- D. Secure fasteners according to manufacturer's recommended torque settings.
- E. Support piping, ductwork, conduit, and mechanical equipment from the building structure. Do not support from other equipment, piping, or ductwork.
- F. Install isolators to prevent short-circuiting of the isolation.
- G. All wiring connections to mechanical equipment on isolators shall have a minimum 18 inch long flexible conduit in a "U" shaped loop. Coordinate with Division 26.
- H. Flexible Connectors: Install flexible connectors sized to match equipment connections and to provide sufficient slack for vibration isolation as required.
- I. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Block-up equipment with temporary shims to final operating height. When the system is assembled full load is applied, adjust the isolators shall be adjusted to allow shim removal.

#### **3.3 INSTALLATION OF VIBRATION ISOLATED EQUIPMENT SUPPORT BASES**

- A. All floor-mounted equipment shall be erected on housekeeping pads. Refer to Section "Common Work Results for HVAC" for concrete housekeeping pad requirements.

- B. Maintain minimum 4 inches clearance between isolated equipment and the walls, ceiling, floors, columns, and any other equipment not installed on vibration isolators.
- C. Set steel bases for one inch clearance between housekeeping pad and base.
- D. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
- E. Adjust equipment to be level.
- F. Verify no material is left to short-circuit the isolator.

### 3.4 INSTALLATION OF VIBRATION ISOLATORS

- A. Neoprene Mounting Sleeves, Grommets, and Bushings: Install on vibration isolators to prevent any metal-to-metal contact.
- B. Spring Isolators:
  - 1. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
  - 2. Install springs so that the ends of springs remain parallel, and all springs are installed with adjustment bolts.
  - 3. Locate isolation hangers at the top of hanger rods.
  - 4. Type SPNM: Unless otherwise specified, isolators need not be bolted to the floor for indoor installations.
  - 5. Type SPNH and DDNH: Install the hanger box to allow it to rotate a full 360 degrees without encountering any obstruction.
- C. Isolating Pipe Anchors:
  - 1. Weld anchor base to support steel or bolt base plate to structure. Weld or bolt pipe clamp or bracket to anchor.

### 3.5 EQUIPMENT ISOLATION

- A. Air Handling Units and Fan Coil Units:
  - 1. Floor-mounted (Concealed): Housekeeping pad base, Type SPNM isolation with 0.75 inch static deflection.
  - 2. Floor-mounted (Exposed): Type WP isolation continuous along support.
  - 3. Suspended: Flexible duct connectors with Type SPNH with 1 inch static deflection.
- B. Inline Pumps:
  - 1. Pump supported in-line with piping: Provide vibration isolators on the piping per the article "Pipe Isolation" below.
  - 2. Pump supported independent of piping:
    - a. Provide flexible connectors on each side of pump. The vertical load shall be carried by the supports, not by the flexible couplings.
    - b. Floor Mounted, Slab-on-Grade: Provide housekeeping pad with Type WP or Type DP, type as required to support weight of pump and components, isolation continuous along support.
    - c. Floor Mounted, Suspended Slab:
      - 1) 5 hp and smaller: Housekeeping pad with Type WP isolation continuous under support.
      - 2) Greater than 5 hp: Housekeeping pad under Type CIB base, Type SPNM isolation with 0.75 inch static deflection.
    - d. Suspended: Type SPNH isolation with 2 inch static deflection.
- C. Unit Heaters: Type SPNH isolation with 2 inch static deflection.
- D. All other equipment not specifically identified in this specification that contains rotating or vibrating elements and any associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM or RNM neoprene isolators as appropriate.

### 3.6 PIPING ISOLATION

- A. Provide isolation supports on the following HVAC pipe:
  - 1. Piping within 20 feet of the following suspended equipment: Provide Type SPNH isolators. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 0.75 inch.



- B. Provide flexible connectors for piping system connections on equipment side of shutoff valves for all pumps, mechanical equipment supported or suspended by spring isolators, and where indicated on Drawings.
- C. Provide resilient diagonal mountings or other approved devices as required to limit piping motion due to equipment startup or shut down to a maximum of 1/8 inch.
- D. Where supplementary steel is required to support pipes, size the supplementary steel so that maximum deflection between supports does not exceed 0.08 inches. Isolate the supplementary steel from building structure using the same isolator required for the pipe. Rigidly suspend or support the pipe from the supplementary steel.
- E. Provide pre-compressed hanger rod isolators for all pipes greater than 12 inch diameter and all supplementary steel supports used for the large pipe. Factory set the pre-compression at 75 percent of rated deflection.
- F. Where isolated pipe 8 inch and larger is supported from exposed steel beams, use welded channel beam attachments located directly under the web of the beam. For piping 6 inch and smaller, beam clamps may be used in lieu of welding, subject to approval of beam clamp selection.
- G. Vertical Piping Riser Supports:
  - 1. Do not exceed pipe stresses allowed by ASME B31.9.
  - 2. Provide multiple supports along riser so that each isolator support is loaded for 50 psi maximum. Provide tapped hole in top of support for rigid attachment of pipe riser clamp to support.
  - 3. Riser Supports: Pipe clamp on top of Type DP or Type WP.
  - 4. Risers Subject to Thermal Expansion:
    - a. Support vertical pipe risers subjected to thermal expansion and/or contraction with spring isolators, anchors, and guides designed to ensure loading within design limits at support points. Perform design calculations for sizing the riser supports incorporating the initial load, initial deflection, change in deflection, final load and change in load at support locations. Design calculations must include anchor loads when installed, cold filled and at operating temperature and pipe stress at end connections and branch locations. Design system for an initial spring deflection of at least 4 times the thermal movement. Design must be stamped and signed by a licensed professional engineer.
    - b. Spring Isolators: Type SPNH, DDNH, or PRSA.
    - c. Anchors: Type PRA.
    - d. Guides: Type PRG.
    - e. Reference Section "Expansion Fittings and Loops for HVAC Piping" for expansion joints.

### 3.7 DUCT ISOLATION

- A. Connect ducts to equipment, fans, fan casings, and fan plenums with flexible connectors.

### 3.8 FIELD QUALITY CONTROL

- A. Arrange for inspection of all isolation and noise control equipment by the vibration isolation vendor and submit post-installation inspection report.
- B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.
- C. Guarantee: If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

### END OF SECTION 230550

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## **SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Pipe markers.
- E. Ceiling tacks.
- F. Engraved plastic-laminate signs.

#### **1.2 SUBMITTALS**

- A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Valve Tag Schedule: Submit 8-1/2 x 11 inch typewritten valve schedule. Furnish one extra copy for each maintenance manual. Include the following information in the schedule:
  - 1. Valve tag number.
  - 2. Piping system and system abbreviation as shown on tag.
  - 3. Location of valve (room or space).
  - 4. Variations for identification (if any).
  - 5. Function. Specially mark valves which are intended for emergency shut-off and similar special uses in margin of schedule.
  - 6. Valve manufacturer's name and model number.
- C. Product Data: Submit manufacturer's technical product data for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures and installation for each product required.

#### **1.3 SPARE PARTS**

- A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.
- B. Furnish not less than 3 additional numbered valve tags for each piping system.
- C. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock along with stenciling paints and applicators.

### **PART 2 - PRODUCTS AND MATERIALS**

#### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Advanced Graphic Engraving, LLC.
- B. Brady Corporation.
- C. Brimar Industries, Inc.
- D. Craftmark.

- E. Industrial Safety Supply Co., Inc.
- F. Kolbi Pipe Marker Co.
- G. MIFAB, Inc.
- H. Seton Identification Products, a Tricor Direct Company..

## 2.2 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

- A. General:
  - 1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.
  - 2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.
  - 3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).
- B. Air Handling Units: Nameplates, or engraved plastic laminate signs.
- C. Air Terminal Units: Tags, or engraved plastic laminate signs.
- D. Automatic Controls: Tags, use the same naming convention coordinated with the building automation system.
- E. Control Panels: Nameplates.
- F. Dampers: Ceiling tacks where located above lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.
- G. Ductwork: Adhesive-backed duct markers.
- H. Fans: Nameplates, or engraved plastic laminate signs.
- I. Heat Transfer Equipment: Nameplates, or engraved plastic laminate signs.
- J. Humidifiers: Nameplates or engraved plastic laminate signs.
- K. Instrumentation: Tags.
- L. Major Control Components including Variable Frequency Drives: Nameplates or engraved plastic laminate signs.
- M. Piping: Pipe Markers.
- N. Pumps: Nameplates or engraved plastic laminate signs.
- O. Relays: Tags.
- P. Small-sized Equipment: Tags.
- Q. Tanks: Nameplates or engraved plastic laminate signs.
- R. Thermostats: Nameplates.
- S. Valves: Tags. Ceiling tacks are acceptable where located above a lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.
- T. Water Treatment Devices: Nameplates or engraved plastic laminate signs.

- U. General Signs: Engraved plastic laminate signs.

## 2.3 NAMEPLATES

- A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
  - 1. Name and mark number.
  - 2. Equipment service.
  - 3. Design capacity.
  - 4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
- B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.
- C. Letter Color: White.
- D. Letter Height: 1/4 inch.
- E. Background Color:
  - 1. Cooling equipment: Green.
  - 2. Heating equipment: Yellow.
  - 3. Combination cooling and heating equipment: Yellow/Green.
  - 4. Energy reclamation equipment: Brown.
  - 5. Hazardous equipment: Colors and designs recommended by ASME.
  - 6. Equipment and components that do not meet any of the above criteria: Blue.
- F. Plastic: Conform to ASTM D709.

## 2.4 TAGS

- A. Plastic Laminate Tags: Laminated three-layer plastic, minimum 3/32 inch thick, with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.
- B. Solid Plastic Tags: Solid plastic, minimum 3/32 inch thick, with printed black letters on white color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.
- C. Metal Tags: Provide 19-gauge polished brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with black enamel paint.
- D. Accident Prevention Tags: Pre-printed or partially pre-printed, of plasticized card stock with matte finish suitable for writing, minimum 3-1/4 inch x 5-5/8 inch size, with brass grommet in hole for fastener. Order with appropriate pre-printed wording (e.g., DANGER, CAUTION, DO NOT OPERATE, etc.).
- E. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the size required for proper attachment of tags to valves, manufactured specifically for that purpose.
- F. Valve Tag Chart: Typewritten letter size list in anodized aluminum or finished hardwood frame, covered with SSB-grade sheet glass. Provide frame and mounting screws for removable mounting.
- G. Letter Height:
  - 1. System Abbreviation: Minimum 1/4 inch.
  - 2. Valve Number: Minimum 1/2 inch.

## 2.5 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual label.
- C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.

- D. Specialty Exhaust: Identify the specialty using the system terminology (e.g., Grease, Dishwasher, Dryer, Fume Hood, etc.).
- E. Color: Yellow background with black lettering or blue background with white lettering.
  - 1. Hazardous Exhaust: Use colors and designs recommended by ASME A13.1.

## 2.6 PIPE MARKERS

- A. Semi-rigid 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.
- B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum 3 mil thick.
  - 1. Width: 1-1/2 inch for pipes less than 6 inches (including insulation), 2-1/2 inch for pipes 6 inches and larger (including insulation).
- C. Pipe Marker with Insulation: 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Insulation shall extend 2 inches beyond each end of plastic pipe marker.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
  - 1. Detection: Provide multi-ply tape consisting of solid aluminum foil core between two layers of plastic ribbon tape.
- E. Nomenclature: Manufacturer's standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as selected by the Engineer.
- F. Arrows: Provide pipe markers with integral arrows indicating direction of flow or as a separate unit of plastic.
- G. Color:
  - 1. Conform to ASME A13.1.
  - 2. Heating, Cooling, and Boiler Feedwater: Green with white letters.
  - 3. Toxic and Corrosive Fluids: Orange with black letters.
  - 4. Compressed Air: Blue with white letters.
- H. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

## 2.7 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color:
  - 1. HVAC Equipment: Yellow.
  - 2. Fire Dampers and Smoke Dampers: Red.
  - 3. Heating/Cooling Valves: Blue.

## 2.8 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Engraving stock melamine plastic laminate, engraved with manufacturer's standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:
  - 1. Name and mark number.
  - 2. Equipment service.

3. Design capacity.

- E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

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

#### **3.2 GENERAL INSTALLATION**

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Install products in accordance with manufacturer's instructions.
- C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- D. Install tags on piping 3/4 inch diameter and smaller.
- E. Install in clear view and align with axis of piping.
- F. Identify service, flow direction, and pressure.

#### **3.3 PIPING IDENTIFICATION**

- A. General: Install identification on the most obviously visible portion of the pipe from the point of access.
- B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- C. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe during back-filling/topsoiling of each underground piping system. Where multiple pipes are buried in common trench and do not exceed overall width of 16 inches, install single pipe marker. For tile fields and similar artificial field installations, mark only edge pipelines of field.
- D. Pipes less than 6 inches diameter (including insulation). Provide full-band pipe markers with 360 degree coverage.
- E. Pipes 6 inches diameter and larger (including insulation): Provide either full-band or strip-type pipe markers.
- F. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:
1. Within 5 feet of each valve, tee, and control device.
  2. Within 5 feet of each branch, excluding branches less than 25 feet in length to fixtures or terminal heating and cooling units.
  3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
  4. At access doors, manholes and similar access points which permit view of concealed piping.
  5. Within 5 feet of equipment outlets and other points of origination and termination.
  6. Spaced intermediately at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.

#### **3.4 VALVE IDENTIFICATION**

- A. Provide a tag on each valve, cock, and control device. Exclude check valves, valves within factory-fabricated equipment, HVAC terminal devices, and similar rough-in connections of end-use fixtures and units.

- B. Mount valve tag chart and schedule frame in mechanical room, or where indicated on plans. If not indicated, mount where directed by Engineer. Where more than one mechanical room is included on the project, mount framed copies of valve tag chart and schedule in each mechanical room.

### 3.5 DUCTWORK IDENTIFICATION

- A. Install identification on the most obviously visible portion of the duct from the point of access.
- B. Location: Install ductwork identification where ductwork is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc), and exterior non-concealed locations as follows:
  - 1. Within 5 feet of each control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.
  - 2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.
  - 3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
  - 4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.
  - 5. Within 5 feet of equipment outlets and other points of origin or termination.
  - 6. Install marker on the most obviously visible portion of the duct from point of access.

### 3.6 ACCESS DOOR IDENTIFICATION

- A. Provide identification on each access door, indicating purpose of access, maintenance and operating instructions, and appropriate safety and procedural information.
- B. Where access doors are concealed above a removable ceiling system or similar concealment, tags may be used in lieu of specified identification.

### 3.7 CEILING TACK INSTALLATION

- A. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

### 3.8 EQUIPMENT IDENTIFICATION

- A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:
  - 1. To distinguish between multiple units in close proximity.
  - 2. To inform operator of operational requirements.
  - 3. To indicate safety and emergency precautions.
  - 4. To warn of hazards and improper operations.
- B. Adjust lettering size based on viewing distance from normal location of identification:
  - 1. Less than 2 feet: Minimum 1/4 inch.
  - 2. Up to 6 feet: Minimum 1/2 inch.
  - 3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.
  - 4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
  - 5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.
- C. Where equipment to be identified is concealed above acoustical ceilings or similar removable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

### END OF SECTION 230553



## **SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. General testing, adjustment, and balancing requirements.
- B. Pre-testing, adjustment, and balancing of existing air systems.
- C. Pre-testing, adjustment, and balancing of existing hydronic systems.
- D. Testing, adjustment, and balancing of air systems.
- E. Testing, adjustment, and balancing of hydronic systems.
- F. This section excludes:
  - 1. Testing boilers and pressure vessels for compliance with safety codes;
  - 2. Specifications for materials for patching mechanical systems;
  - 3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
  - 4. Requirements and procedures for piping and ductwork systems leakage tests.

#### **1.2 DEFINITIONS**

- A. TAB: Testing, adjusting, and balancing.
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report forms: Data sheets arranged for collecting test data in logical order for submission and review. Data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. Examples include inlets and outlets on water terminals, inlets and outlets from air terminal units, and inlets and outlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- H. Main: Duct or pipe containing the major or entire fluid flow of the system.
- I. Submain: Duct or pipe containing part of the system capacity and serving two or more branch mains.
- J. Branch main: Duct or pipe serving two or more terminals.
- K. Branch: Duct or pipe serving a single terminal.

#### **1.3 SUBMITTALS**

- A. Qualifications:
  - 1. Submit qualifications of TAB agency.
  - 2. Submit qualifications of TAB supervisor.

- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
- C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Progress Reports.
- F. Certified TAB Reports:
  - 1. General:
    - a. Submit within two weeks after completion of testing, adjusting, and balancing.
    - b. Revise TAB plan to reflect actual procedures and submit as part of final report.
    - c. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
  - 2. Draft Report: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be handwritten, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
  - 3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:
    - a. The systems have been tested, adjusted, and balanced in accordance with the referenced standards.
    - b. The report reflects an accurate representation of how the systems have been installed.
    - c. The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.
    - d. The report is an accurate record of all final quantities measured to establish normal operating values of the systems.
  - 4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, and cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:
    - a. General Information and Summary
      - 1) Include project name, location, altitude, and date.
      - 2) Identify TAB agency, contractor, owner, architect, and engineer.
      - 3) Include addresses, contact names, and telephone numbers.
      - 4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.
      - 5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.
    - b. Air Systems
    - c. Hydronic Systems
    - d. Temperature Control Systems
  - 5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE 111.
  - 6. Units of Measure: Report data in I-P (inch-pound) units only.
- G. Project Record Documents: Provide drawings that record actual locations of flow measuring stations and balancing devices.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
- B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter "Testing, Adjusting, and Balancing", most current edition.
- C. TAB Agency Qualifications:

1. Act as the single source of responsibility for TAB of the HVAC systems.
  2. Staff the project at all times by qualified personnel.
  3. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.
  4. Certified by one of the following Certification Associations:
    - a. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
    - b. TABB: Testing, Adjusting, and Balancing Bureau, SMACNA TAB Procedural Guide.
- D. TAB Supervisor and Technician Qualifications:
1. Certified by the same organization as TAB agency.
  2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.
- E. Pre-Qualified TAB Agencies:
1. AccuTech
  2. Doyle Field Services.
  3. Precisionaire of the Midwest.
  4. Pro Balance.
  5. Total Air Balance.

## **PART 2 - PRODUCTS AND MATERIALS – NOT USED**

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.
- B. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.
- C. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.
- D. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- E. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.
- F. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.
- G. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- H. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

### **3.2 EXAMINATION**

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  1. Systems are started and operating in a safe and normal condition.
  2. Temperature control systems are installed complete and operable.
  3. Proper thermal overload protection is in place for electrical equipment.
  4. Motors and bearings are lubricated.
  5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  6. Duct systems are clean of debris.

7. Fans are rotating correctly, and belts have tension.
8. Fire, smoke, fire/smoke, and volume dampers are in place and open.
9. Air coil fins are cleaned and combed.
10. Volume dampers are installed at locations needed for balancing the air systems.
11. Access doors are closed and duct end caps are in place.
12. Air outlets are installed and connected.
13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.
14. Hydronic systems are flushed, filled, and vented.
15. Hydronic systems are tested for leaks.
16. Test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves are properly installed and that their location is accessible.
17. Pumps are rotating correctly.
18. Proper strainer baskets are clean and in place.
19. Service and balance valves are open.
20. Expansion tanks are not air bound and have appropriate charge.
21. Air vents are operating freely.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

### 3.3 PREPARATION

A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.

B. Furnish all instruments required for testing, adjusting, and balancing operations.

1. Verify all instruments have been calibrated.
2. Furnish instruments as recommended by the manufacturer for the TAB application.
3. Furnish instruments that are best suited to the function being measured.
4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.

D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.

E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

F. Determine best locations in main and branch ductwork for most accurate duct traverses.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

### 3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.

B. Air Outlets and Inlets: Balance branch ducts and terminal devices to within plus or minus 10 percent of design airflow.

C. Hydronic Systems: Balance to within plus or minus 5 percent of design flow.

### 3.5 RECORDING AND ADJUSTING

A. Record data regarding design conditions from contract documents and installed conditions from shop drawings including equipment identification number, model number, location, area served, manufacturer, model number, serial number, motor nameplate horsepower and rpm, fan rpm, capacity and electrical voltage, amps and phases.

B. For all systems measure and record the ambient conditions at the time of testing and balancing. Include the following:

1. Dry bulb temperature.

2. Relative humidity.
3. Cloud cover.
4. Wind speed.
5. Time.

C. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

D. Ensure recorded data represents actual measured or observed conditions.

E. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

F. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

H. Cut insulation around ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

I. Patch and seal insulation, vapor barrier, ductwork, and housings, using materials identical to those removed.

J. Seal ducts and piping and test and repair leaks.

K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

L. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

M. Check and adjust systems approximately six months after final acceptance and submit report.

N. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive values are obtained.

O. Take all readings at eye level of the indicated value to prevent parallax.

P. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

Q. Take measurements in the system where best suited for the task.

R. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

### 3.6 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING AIR SYSTEMS

A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.

B. Units to be pre-tested:  
1. AHU-1E-6E.

C. TAB Contractor:

1. Measure and record the operating speed, airflow, and total and external static pressure of each fan system. Provide individual pressure drop readings across all coils, filter banks, dampers and other internal fan system components
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. For variable air volume systems: Open automatic air dampers to full design position to simulate a design day. Measure and record the operating speed and airflow of each fan system for full load conditions.
8. Report on the results of the measurements taken and any deficiencies.

D. Mechanical Contractor:

1. Report on the operating condition of the equipment and any deficiencies.

### 3.7 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING HYDRONIC SYSTEMS

- A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.

B. Units to be pre-tested:

1. Existing chilled and heating water pumps.

C. TAB Contractor:

1. Open automatic control valves to full design position to simulate a design day. Close coil bypass valves.
2. Examine HVAC system and equipment installations to verify that existing balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices and balancing valves and fittings are properly installed. Verify that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
3. Remove, clean, and reinsert all strainers.
4. Examine hydronic systems and determine if water has been treated and cleaned.
5. Check pump rotation.
6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
7. Check air vents at high points of systems and determine if all are operating freely (automatic type) or to bleed air completely (manual type).
8. Set temperature controls so all coils are calling for full flow.
9. Check operation of automatic bypass valves.
10. Measure and record the operating speed, hydronic flow and pressure drop of each pump and hydronic coil.
11. Measure and record the hydronic flow and pressure drop of each piece of HVAC equipment.
12. Measure motor voltage and amperage. Compare the values to motor nameplate information.

D. Mechanical Contractor:

1. Install additional instrumentation and test ports as requested by the testing, adjusting, and balancing contractor to obtain the necessary measurements of the existing system.

### 3.8 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Check filters for cleanliness.
- B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
- C. Verify volume dampers are installed at locations needed for balancing the air systems.
- D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- E. Determine best locations in main and branch ductwork for most accurate duct traverses.
- F. Place outlet dampers in the full open position.

- G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
- H. Lubricate all motors and bearings.
- I. Check fan belt tension.
- J. Check fan rotation.
- K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.
- L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- M. Measure air quantities at air inlets and outlets.
- N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- O. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices such as dampers and splitters.
- P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- R. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- T. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- U. Where modulating dampers are provided, take measurements and balance at design conditions. Balance variable volume systems at design air flow rate and at minimum air flow rate.
- V. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship to maintain building pressure setpoint.
- W. For variable air volume boxes, set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- X. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:
  - 1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.
  - 2. Operate supply fan at design speed and measure the outdoor airflow.
  - 3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.
  - 4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.
  - 5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.
  - 6. Repeat this procedure to determine damper position for absolute minimum ventilation.

### 3.9 HYDRONIC SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Open valves to full open position. Close coil bypass valves.
- B. Remove and clean all strainers.
- C. Check pump rotation.

- D. Clean and set automatic fill valves for required system pressure.
- E. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- F. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
- G. Set temperature controls so all coils are calling for full flow.
- H. Check operation of automatic bypass valves.
- I. Check and set operating temperatures of chillers to design requirements.
- J. Lubricate all motors and bearings.
- K. Adjust water systems to provide required or design quantities.
- L. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on correlated flow from temperature and pressure gauges across the heat transfer elements in the system.
- M. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- N. Affect system balance with automatic control valves fully open to heat transfer elements.
- O. Affect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- P. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
- Q. Balance cooling tower water distribution systems to ensure even water flow to each tower cell.
- R. Test cooling tower systems for capacity, recording pump flow and head, fan airflow, ambient air wet and dry bulb temperatures at tower inlet and outlet and tower inlet and outlet water temperatures.
- S. Record the necessary information for optimizing pump operation as defined on the control's drawings. Give this information to the controls contractor for building automation system programming.

**END OF SECTION 230593**



## **SECTION 230700 - HVAC INSULATION**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Piping Insulation.
- B. Equipment Insulation.

#### **1.2 RELATED REQUIREMENTS**

- A. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, pipe saddles, and high-density insulation inserts.
- B. Division 23 Section "Buried Hydronic Piping," for insulation of piping installed below grade.
- C. Division 23 Section "Metal Ducts" for duct liner insulation.

#### **1.3 DEFINITIONS**

- A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.
- B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.
- C. Cold Duct: Ductwork that carries airflow with a minimum operating temperature less than 65 degrees F temperature.
- D. Neutral Ductwork: Ductwork that carries airflow with temperatures between the defined cold and hot temperatures.
- E. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees F.
- F. Exposed: Insulation that is visible from the occupied space.
- G. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.
- H. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.
- I. Unconditioned Spaces: An enclosed space within a building that is not provided with mechanical heating or cooling.

#### **1.4 SUBMITTALS**

- A. Product Data: Submit technical product data, thermal characteristics, and materials for each type of mechanical insulation.
- B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
  - 1. Exception: Exterior mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
  - 2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.
  - 3. Exception: Polyisocyanurate insulation that is not installed in a return air plenum may have a flame spread index of 25 and smoke developed index of 450.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

## 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 PIPING INSULATION MATERIALS

- A. Mineral Fiber (rock, slag, or glass):
  - 1. Manufacturers:
    - a. Johns Manville.
    - b. Knauf Insulation.
    - c. Owens Corning.
  - 2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.
    - a. K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.
    - b. Minimum Service Temperature: 0 degrees F
    - c. Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.
    - d. Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.
  - 3. Factory Applied Jacket: ASTM C1136, Type I.
    - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.
    - b. Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.
    - c. Color: White.
- B. Flexible Elastomeric:
  - 1. Manufacturers:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. K-Flex USA.
  - 2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.
    - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.

- b. Minimum Service Temperature: Minus 297 degrees F
  - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
- 3. Factory Applied Jacket:
  - a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Piping Jacket Schedule in Part 3 of this specification for application of this jacket.
- C. Field-Applied Jacket:
  - 1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
  - 2. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
    - a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
    - b. Manufacturers:
      - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
      - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
      - 3) Or approved equal.
  - 3. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in)		
	Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco
≤ 36	0.032	0.020	See Note 1
> 36	0.040	0.024	See Note 1

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

- a. Banding:
      - 1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
      - 2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.
  - 4. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
    - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
    - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
  - 5. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulated duct and piping applications. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding or approved equal.
    - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
    - b. Puncture Resistance: Minimum 15 pounds per ASTM D1000.
- D. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
- 1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
  - 2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.
  - 3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
  - 4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05

Pipe and vessels (-40 F to 32 F)	0.02	0.02
Ducts (40 F to ambient)	1.0	0.03

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
5. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.

- F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

## 2.2 EXTERNAL DUCTWORK INSULATION MATERIALS

- A. Flexible Mineral Fiber (rock, slag, or glass):
1. Manufacturers:
    - a. CertainTeed Corp.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  2. Insulation: ASTM C553, Type I or II, flexible mineral fiber blanket.
    - a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
    - b. Minimum Service Temperature: Minus 20 degrees F
    - c. Maximum Service Temperature: 450 degrees.
    - d. Density:
      - 1) 1.5 pounds per cubic foot.
  3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
    - a. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch stapling tab.
    - b. Polypropylene Scrim Kraft (PSK): Kraft paper with glass fiber yarn and bonded to metalized polypropylene, water vapor permeance of 0.02 perms and 2 inch stapling tab.

## 2.3 EQUIPMENT INSULATION MATERIALS

- A. Flexible Elastomeric:
1. Manufacturers:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. K-Flex USA.
  2. Insulation: ASTM C534, Grade I or II, flexible elastomeric cellular rubber insulation, sheet form.
    - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
    - b. Minimum Service Temperature: Minus 40 degrees F
    - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
- B. Field-Applied Jacket:
1. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.
    - a. Thickness: 0.032 inch sheet.
    - b. Finish: Smooth.
    - c. Joining: Longitudinal slip joints and 2 inch laps.
    - d. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
- C. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- D. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coating, sealers, mastics, and protective finishes as recommended by insulation manufacturer for applications indicated.
1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36. Childers CP-50AHV2 or equal.
  2. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

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

### **3.2 PROTECTION AND REPLACEMENT**

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.
- B. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.
- C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

### **3.3 INSTALLATION, GENERAL**

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

### **3.4 PIPING SYSTEM INSULATION INSTALLATION**

- A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Exposed Piping: Locate insulation and cover seams in least visible locations.
- E. Cold Pipe Insulation:
  - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
  - 2. Provide vapor barrier jacket according to the Piping Jacket Schedule.
  - 3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
  - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
  - 5. Secure all-service jacket with self-sealing longitudinal laps.
  - 6. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.
- F. Hot Pipe Insulation:
  - 1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
  - 2. Provide jackets without vapor barrier according to the Piping Jacket Schedule. Jackets with vapor barrier are allowed.
  - 3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers &

Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Secure all-service jacket with self-sealing longitudinal laps.
6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation of Fittings, Valves, Strainers, Flanges, and Unions:

1. Insulate fittings, joints, and valves with molded insulation of like material, vapor barrier coating, and thickness as adjacent pipe. Provide pre-formed insulation pieces, segmented insulation, or sectional pipe insulation for the application. Provide the same insulation jacket as adjoining pipe.
2. Sectional pipe insulation: Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Hold sectional cuts in place with tie wire or bands. Wire and bands shall be compatible with insulation and jacket.
3. Segmented pipe insulation: Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.
4. Butt each insulation piece tightly against adjoining piece of insulation. Bond pieces together according to Cold Pipe or Hot Pipe installation instructions.
5. Insulate valves up to and including the bonnets, valve stuffing-box studs, bolts, and nuts with a removeable insulation cover. Sectional valve insulation covers shall divide the section along the vertical center line of the valve body.
6. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover.
7. Insulate flanges and unions with a removeable insulation cover. Sectional pipe insulation covers shall divide the section along the center line of pipe.
8. When removeable covers are made from sectional block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, around the insulated device with tie wire. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
9. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. PVC fitting covers with end caps are also acceptable. Tape PVC covers to adjoining insulation facing using PVC tape.
10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Maintain vapor barrier through the penetration.

J. Exterior Piping and Piping Exposed to Weather:

1. Rigid aluminum shell: Space attachment bands 12 inches on center and directly centered over end joints.

### 3.5 PIPING SYSTEM INSULATION SCHEDULE

A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.

B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.

C. Omit insulation on the following:

1. Cold piping within unit cabinets provided piping is located over drain pan.
2. Condensate piping between steam trap and union.
3. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.

D. Exterior Piping: Insulate all exterior HVAC piping with one of the following:

1. Flexible elastomeric, use high temperature formula for systems with operating temperatures above 220 F. (not acceptable for steam, steam condensate or hot water piping systems with temperatures above 300 F).

- E. Cold Piping (40 degrees F (4.4 degrees C) to 60 degrees F):
1. Service:
    - a. Chilled water supply and return piping.
  2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
    - a. Mineral fiber.
    - b. Flexible elastomeric – exterior piping.
- F. Hot Non-Steam Piping (141 to 200 degrees F (61 to 94 degrees C)):
1. Service:
    - a. Heating hot water supply and return piping.
  2. RAcceptable Insulation:
    - a. Mineral fiber.

### 3.6 PIPE INSULATION THICKNESS SCHEDULE

#### A. IECC – 2018 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness							
Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu.in./(hr.ft².°F)	Mean Rating Temp., °F.	<1	1 to	1-1/2	4 to	≥8
			<1-1/2	to <4	<8		
Insulation Thickness, in.							
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

#### Notes:

1. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
2. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:  
 $T = r[(1 + t/r)^{(K/k)} - 1]$  where
  - a. T = minimum insulation thickness (in.),
  - b. r = actual outside radius of pipe (in.),
  - c. t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
  - d. K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
  - e. k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
3. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
4. For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”
5. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

### 3.7 PIPING JACKET SCHEDULE

- A. Exposed piping within mechanical rooms (below 10 feet):
1. Rigid aluminum shell.
- B. Exposed piping within mechanical rooms (above 10 feet):
1. Semi-rigid PVC.
- C. Exposed piping:
1. All-service jacket.

- D. Piping within return air plenums:
  - 1. All-service jacket.
- E. Exterior piping and piping exposed to weather:
  - 1. Paintable coating (flexible elastomeric insulation only.)
  - 2. Polymeric Coating (flexible elastomeric insulation only).
  - 3. Rigid aluminum shell.

### 3.8 DUCTWORK INSULATION SYSTEM INSTALLATION

- A. Maintain continuous thermal and vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on duct systems subsequent to painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces.
- D. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Install insulation without sag on underside of duct. Where rectangular ducts are 24 inches in width or greater, secure external insulation to the bottom of the duct with mechanical fasteners, spaced on 18 inches on center (maximum). Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Secure insulation to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention. Lift duct off trapeze hangers and insert spacers to avoid insulation compression.
- F. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- G. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.
- H. Lined Ductwork: At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.
- I. Cold Ducts:
  - 1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
  - 2. Provide vapor barrier jacket according to the Ductwork Jacket Schedule.
  - 3. Seal joints with vapor barrier mastic.
  - 4. Continue insulation, including vapor barrier, through walls, sleeves, hangers, and other duct penetrations.
  - 5. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
  - 6. Where cold ducts are installed in mechanical rooms or non-conditioned spaces (excludes return air plenums), prevent condensation from forming on the duct supports by providing one or more of the following:
    - a. Install thermal break such as rigid board insulation between the support and duct.
    - b. Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12 inches from point of contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4 inch wide coating of vapor barrier mastic.
    - c. If a support device similar to Unistrut is used, foam fill or stuff tube.
- J. Hot and Neutral Ducts:
  - 1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
  - 2. Provide jackets with or without vapor barrier according to the Ductwork Jacket Schedule.
  - 3. Secure joints with staples, tape, or wires.
  - 4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

### 3.9 DUCTWORK SYSTEM INSULATION SCHEDULE

- A. Omit insulation on the following:
  - 1. Fibrous glass ductwork (duct board).



2. Lined ductwork that is interior to the building unless otherwise indicated on the drawings. Ductwork with sound absorbing linings unless otherwise indicated on the drawings.
- B. Prohibited insulation:
    1. Polyisocyanurate installed within a return air plenum.
  - C. Outdoor Air:
    1. Service:
      - a. Interior untreated outdoor air intake ducts.
      - b. Pre-conditioned outdoor air ducts.
    2. Acceptable Insulation:
      - a. Flexible mineral fiber.
  - D. Supply Air:
    1. Service:
      - a. Supply ducts from air handling equipment.
    2. Acceptable Insulation:
      - a. Flexible mineral fiber.
  - E. Return Air:
    1. Service:
      - a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
      - b. Interior ductwork routed through or from unconditioned spaces and plenums.
    2. Acceptable Insulation:
      - a. Flexible mineral fiber.
  - F. Exhaust Air.
    1. Service:
      - a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
      - b. Interior ductwork routed through conditioned spaces (excludes ductwork routed in shafts) that is exhausting from unconditioned spaces (such as loading docks, garages, etc.).
      - c. Interior ductwork downstream of heat recovery device (wheel, plate, heat pipe, etc.) to exterior discharge outlet.
    2. Acceptable Insulation:
      - a. Flexible mineral fiber.
  - G. Relief Air.
    1. Service:
      - a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
      - b. Downstream of heat recovery device (wheel, plate, heat pipe, etc.) to exterior discharge outlet.
    2. Acceptable Insulation:
      - a. Flexible mineral fiber.

### 3.10 DUCT SYSTEM INSULATION THICKNESS SCHEDULE

- A. Flexible Mineral Fiber:
  1. Interior Ductwork:
    - a. 0.75 pounds per cubic foot density:
      - 1) 2-1/4 inch thick, minimum R-6.0.
    - b. 1.5 pounds per cubic foot density:
      - 1) 2 inch thick, minimum R-6.0.
  2. Meet R-value installed at maximum 25% compression, application limited to concealed locations.
  3. Ductwork installed in machine, fan, and mechanical equipment rooms:
    - a. 2 inch thick, minimum R-8.0.
  4. Ductwork in an Unconditioned Space:
    - a. 1-1/2 inch thick, minimum R-6.0.

### 3.11 DUCTWORK JACKET SCHEDULE

- A. Omit jacket on internally lined ductwork.
- B. Exposed ductwork within mechanical rooms (below 10 feet):

1. Foil Scrim Kraft (FSK).
  2. Polypropylene Scrim Kraft (PSK).
  3. All-Service Jacket (ASJ).
  4. Polypropylene Scrim Polyester (PSP).
  5. Flexible Metal Cladding (flexible elastomeric only).
  6. Aluminum with smooth finish.
- C. Exposed ductwork within mechanical rooms (above 10 feet):
1. Foil Scrim Kraft (FSK).
  2. Polypropylene Scrim Kraft (PSK).
  3. All-Service Jacket (ASJ).
  4. Polypropylene Scrim Polyester (PSP).
  5. Flexible Metal Cladding (flexible elastomeric only).
- D. Exposed ductwork:
1. Foil Scrim Kraft (FSK).
  2. Polypropylene Scrim Kraft (PSK).
  3. All-Service Jacket (ASJ).
  4. Polypropylene Scrim Polyester (PSP).
  5. Flexible Metal Cladding (flexible elastomeric only).
  6. Aluminum with smooth finish.
- E. Ductwork within return air plenums:
1. Foil Scrim Kraft (FSK).
  2. Polypropylene Scrim Kraft (PSK).
  3. All-Service Jacket (ASJ).
  4. Polypropylene Scrim Polyester (PSP).
  5. Flexible Metal Cladding (flexible elastomeric only).
- F. Ductwork in an unconditioned space:
1. Foil Scrim Kraft (FSK).
  2. Polypropylene Scrim Kraft (PSK).
  3. All-Service Jacket (ASJ).
  4. Polypropylene Scrim Polyester (PSP).
  5. Flexible Metal Cladding (flexible elastomeric only).

### 3.12 EQUIPMENT INSULATION INSTALLATION

- A. Install insulation subsequent to painting, testing, and acceptance of tests.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Protect insulation to prevent puncture and other damage.
- D. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- E. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.
- F. Do not apply insulation to equipment, breechings, or stacks while hot.
- G. Do not insulate flanges and unions of equipment carrying fluids less than 105 degrees F.
- H. Provide neatly beveled edge at interruptions of insulation.
- I. Fasten insulation to equipment with studs, pins, clips, adhesives, wires, or bands.
- J. Stagger insulation joints for both single- and double-layer application, where feasible. Apply each layer of insulation separately. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.

- K. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- L. Cover insulated surfaces with jacketing, factory or field applied, neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.
- M. Cold Equipment:
  - 1. Insulate entire system, including flanges and unions. Maintain continuous vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.
  - 2. Provide vapor barrier jacket, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.
  - 3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

### 3.13 EQUIPMENT INSULATION SCHEDULE

- A. Omit Insulation on the following:
  - 1. Boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplates.
  - 2. Factory pre-insulated equipment.
- B. Do not apply insulation to equipment that operates outside of the minimum and maximum service temperature range.
- C. Provide flexible removable and reusable blanket insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.
- D. Cold Equipment:
  - 1. Service:
    - a. Refrigeration equipment, including chillers, tanks and pumps.
    - b. Cold surfaces not factory insulated.
    - c. Drip pans under chilled equipment.
    - d. Chilled water storage tanks.
  - 2. Acceptable Insulation:
    - a. Flexible Elastomeric:
      - 1) 3 inch thick for surfaces above 35 degrees F.
      - 2) 4 inch thick for surfaces 35 degrees F and lower.

### END OF SECTION 230700

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## **SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Control panels.
- B. Control valves.
- C. Control dampers.
- D. Operators.
- E. Flow measuring apparatus.
- F. Input/Output sensors and transmitters.
- G. Output control devices.
- H. Power Supplies.
- I. Weather stations.

#### **1.2 DEFINITIONS**

- A. BAS: Building Automation System.
- B. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations.
- C. Cv: Design Valve Flow Coefficient.
- D. DDC: Direct Digital Control.
- E. EPDM: Ethylene Propylene Diene Monomer.
- F. High voltage: 50 volts or higher.
- G. Low voltage: Below 50 volts.
- H. PTFE: Polytetrafluoroethylene.
- I. TEFZEL: A modified ETFE (ethylene tetrafluoroethylene) fluoroplastic.

#### **1.3 CONTRACTOR RESPONSIBILITIES**

- A. Reference Division 23 Section "Electrical Coordination for Mechanical Equipment" for contractor responsibilities.
- B. BAS Contractor:
  - 1. Installation of the BAS shall be by the BAS Contractor or their subcontractors.
  - 2. Low voltage control wiring.
  - 3. Coordinate high voltage control wiring to instrumentation and control devices with Division 26. Where high voltage power is required for instrumentation and control devices that is in addition to what is shown on the drawings, the BAS contractor shall cover the cost of providing this wiring.
  - 4. All interlock wiring regardless of voltage (e.g., exhaust fan interlocked to supply fan).
  - 5. Coordinate with Division 26 that motor starters are provided with auxiliary contacts as required for interlocks.

6. Coordinate power wiring to BAS controllers and instrumentation and control devices with Division 26.
7. Coordinate installation of back-box rough-in for wall-mounted control devices sensors, etc. with Division 26. Coordinate with mechanical contractor all locations, quantities, and sizes required for installation by Division 26.
8. Perform startup and demonstration services as specified in Section "Direct Digital Control for HVAC".

C. Sheet Metal Contractor:

1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
2. Access doors where and as required.

D. Mechanical Contractor:

1. Installation of immersion wells.
2. Installation of flow switches.
3. Installation of automatic control valves.
4. Installation of pressure tappings and associated shut-off cocks.
5. Coordinate conduit and wall box rough-in, power wiring and magnetic starter requirements for controls and mechanical equipment with Division 26.

#### 1.4 SUBMITTALS

A. Refer to Division 01 for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include dimensions, capacities, size, performance characteristics, electrical characteristics, and finishes of materials.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Schedule for control valves and actuators, including the following:

1. Tag.
2. Quantity.
3. Model number.
4. Equipment served.
5. Flow at project design conditions.
6. Selected valve flow coefficient (Cv). For butterfly valves, submit the corresponding valve position at which the Cv is calculated.
7. Pressure differential drop across valve at project design flow conditions and selected Cv.
8. Maximum close-off pressure.
9. Valve Configuration (2-way/3-way).
10. Valve Normal Position and Fail Position (e.g., NO/FO; normally open/fail open).
11. Valve Size.
12. Line Size.
13. Valve Type.
14. Actuator Signal Type (Open/Close, Modulating 0-10 Vdc, 2-10 Vdc, 4-20 mA, etc.)
15. Torque required to close valve at pump shutoff head.
16. Selected actuator maximum torque output.

E. Manufacturer's Instructions: Provide for all manufactured components.

F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

H. Warranty: Submit manufacturer warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- C. Control valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI and MSS standards.
- D. Measurement devices and sensors shall be calibrated using NIST traceable standards.

## 1.6 WARRANTY

- A. Correct defective Work within a one year period after Substantial Completion.
- B. Provide extended warranty for control devices and equipment as specified herein.

## **PART 2 - PRODUCTS**

### 2.1 CONTROL PANELS

- A. Construction:
  - 1. Panel shall be UL 508A listed.
  - 2. NEMA 250, general purpose utility enclosures with enameled finished face panel.
  - 3. NEMA 4X utility enclosure for outdoor or wash-down applications.
  - 4. Provide common keying for all panels.

### 2.2 CONTROL VALVES

- A. General:
  - 1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Each valve shall be equipped with proper packing to ensure there will be no leakage at the valve stem.
  - 2. Pressure Ratings:
    - a. Valve body and packing rated to withstand the system static head plus the maximum pump head and the maximum temperature of the control medium (i.e., chilled water, steam, hot water, etc.).
      - 1) Minimum pressure class 125 psig.
    - b. Two-way modulating valves and their operators shall have close-off pressure ratings exceeding the dead-head condition of the pump in the system it serves.
    - c. Two-way modulating valves with equal percentage flow characteristics and their operators shall be rated to safely operate within a differential pressure range between 2 and 50 psi across the valve without cavitating.
  - 3. Sizing:
    - a. Hydronic Systems:
      - 1) Two-Position: Line size or sized using a pressure differential of 1 psi. Size butterfly valves using the 90 degree flow coefficient (Cv).
      - 2) Modulating: Select valves with an appropriate flow coefficient (Cv) to achieve a minimum design valve authority of 0.5 relative to the total pressure drop of the piping branch the valve controls. Calculate Cv based on the larger of the following:
        - a) 5-psig pressure drop at the design flow rate specified in the Schedules.
        - b) Twice the equipment design pressure drop as specified in the Schedules unless otherwise noted:
          - i) Specific Equipment Pressure Drop (ft H<sub>2</sub>O):
        - c) Valve shall not be less than 1/2 Inch in size.
        - d) Size butterfly valves using the 60 degree of full open flow coefficient (Cv).
  - 4. Flow Characteristics:
    - a. Hydronic Service:
      - 1) Two-way valves: Equal percentage characteristic.

- 2) Three-way valves: Linear characteristic.
5. End Connections:
  - a. Reference the Control Valve Schedule in Part 3 for allowable end connections by pipe material.
  - b. Carbon steel and stainless steel valves shall comply with ASME B16.34.
  - c. Comply with ASME B16.10 for face-to-face and end-to-end dimensions.
  - d. Threads:
    - 1) Comply with ASME B1.20.1.
    - 2) Comply with ASME B16.4 for cast iron.
    - 3) Comply with ASME B16.15 for cast copper alloys, including bronze and brass.
  - e. Flanges:
    - 1) Comply with ASME B16.5 for steel.
    - 2) Comply with ASME B16.1 for cast iron.
    - 3) Comply with ASME B16.24 for cast copper alloys, including bronze and brass.
  - f. Grooved Fittings:
    - 1) Water services to 230 deg F and 250 psig.
- B. Globe Pattern:
  1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size and end connection by application.
  2. Construction:
    - a. Up to 2 inches: Class 150, ASTM B62 bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
      - 1) Bronze body and bonnet shall conform to ASTM B62 up to pressure class 150. Conform to ASTM B61 for pressure class 200 and higher.
    - b. Over 2 Inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
      - 1) Iron body and bonnet shall conform to ASTM A126, class B.
    - c. Bonnet:
      - 1) Bronze body, Class 125: Threaded type.
      - 2) Bronze body, Class 150 or higher: Union type.
      - 3) Iron body: Bolted type.
    - d. Disc Material:
      - 1) PTFE.
      - 2) Stainless steel.
    - e. Stem: Outside screw and yoke. Include extension for insulation.
    - f. Two-piece brass packing gland assembly, non-asbestos composition packing.
  3. Rangeability: Minimum 50:1.
  4. Leakage:
    - a. Up to 1-1/4 Inch: Minimum ANSI Class III per ANSI/FCI 70-2.
    - b. 1-1/2 Inch and Larger: Minimum ANSI Class IV per ANSI/FCI 70-2.
  5. Design and Testing:
    - a. MSS SP-80 for bronze.
    - b. MSS SP-85 for cast iron.
- C. Ball Pattern:
  1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.
  2. Construction:
    - a. Body:
      - 1) Bronze conforming to ASTM B61, B62, and B584.
      - 2) Forged brass with or without nickel plating conforming to ASTM B283.
      - 3) Cast carbon conforming to ASTM A216.
      - 4) Cast iron according to ASTM A126.
      - 5) Stainless steel conforming to ASTM A351.
    - b. Up to 2 inches: Two-piece construction
    - c. 2-1/2 inch to 3 inch: Three-piece construction.
    - d. Stainless steel, blowout proof stem. Include extension for insulation.
    - e. Replaceable PTFE seats and EPDM O-ring or PTFE packing seals.
  3. Ball: Full port with characterized insert comprised of the following material:
    - a. Stainless steel.
    - b. Chrome-plated.
    - c. Nickel-plated.
  4. Rangeability: Minimum 50:1.
  5. Leakage: Minimum ANSI Class IV per ANSI/FCI 70-2.



6. Design and Testing:
  - a. MSS SP-72 for flanged ends.
  - b. MSS SP-110 for threaded and grooved ends.

D. Butterfly Pattern:

1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.
2. Construction:
  - a. Body: Lug ends suitable for connecting to ASME B16.5 flanges, or grooved ends.
    - 1) Cast iron according to ASTM A126.
    - 2) Ductile iron according to ASTM A536.
    - 3) Cast steel according to ASTM A216.
  - b. Disc:
    - 1) Aluminum bronze.
    - 2) Stainless steel.
    - 3) One-piece nylon coated ductile iron disc. Nylon coated discs are not allowed for open loop condenser water systems.
  - c. Stem: 416 Stainless steel. Include extension for insulation.
  - d. Replaceable PTFE or EPDM seats and seals.
3. Rangeability: Minimum 20:1.
4. Leakage: Minimum ANSI Class IV, per ANSI/FCI 70-2.
5. Design and Testing: MSS SP-67 for Class 150 and MSS SP-68 for pressure classes above 150.

E. Manufacturers:

1. Belimo.
2. Bray.
3. Danfoss.
4. Fisher Controls.
5. Griswold Controls.
6. Honeywell.
7. Johnson Controls, Inc.
8. Kele.
9. Schneider Electric.
10. Siemens.
11. Victaulic (Tour & Andersson).

F. Solenoid-Operated Control Valves:

1. Construction:
  - a. Factory fabricated, heavy duty assembly.
  - b. Body and Trim:
    - 1) Bronze
    - 2) Stainless steel.
  - c. Replaceable PTFE seats and disc.
  - d. Solenoid Enclosure: NEMA 250, Type 4.
2. Action:
  - a. As indicated on the drawings.
  - b. Manual override capable.
3. Operator: Spring return with normal position and power requirements as indicated on the drawings.
  - a. Reference Valve Operators section below for additional requirements.

## 2.3 CONTROL DAMPERS

- A. Dampers shall be factory fabricated and sized as shown on drawings and as specified.
- B. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.
- C. Performance: Test in accordance with AMCA 500-D.
  1. Pressure Drop: Unless otherwise scheduled or indicated on the Drawings, size control dampers as follows:
    - a. Modulating Dampers: Provide dampers with linear flow characteristics. Size modulating dampers based on the smaller of the following.
      - 1) Maximum velocity of 1,500 feet per minute.
      - 2) Maximum Full-open air pressure drop of 0.1 inches W.C.
    - b. Two Position Dampers: Dampers shall be full duct size and selected to minimize pressure drop.

2. Leakage:
  - a. Motorized dampers for outdoor, exhaust and relief air and for shaft and stairway vents shall be Class I leakage and shall not exceed 4.0 CFM/square foot in full closed position at 1 inch W.G. pressure differential across damper.
  - b. Motorized dampers for other applications shall be Class II leakage.
- D. Frames: Galvanized steel, extruded aluminum, or stainless steel, welded or riveted with corner reinforcement.
  1. Use minimum 16 gauge for rectangular dampers.
  2. Use minimum 20 gauge for round dampers.
  3. For aluminum frames, use 1/8 inch thick material.
  4. All damper frames shall have a flange for duct mounting.
  5. Reference Part 3 Execution for application of the material type.
- E. Blades: Galvanized steel, extruded aluminum, or stainless steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.
  1. Use minimum 16 gauge for rectangular dampers.
  2. Use minimum 16 gauge for round dampers.
  3. For aluminum blades, use 1/8 inch thick material.
  4. The blades shall be suitable for the air velocities to be encountered in the system.
  5. Dampers longer than the maximum blade length shall be fabricated in sections.
  6. Reference Part 3 Execution for application of the material type.
- F. Blade Seals: Synthetic elastomeric inflatable or Neoprene, mechanically attached, field replaceable.
  1. Installed along the top and bottom of the frame and on all mating surfaces.
- G. Jamb Seals: Spring stainless steel.
  1. Installed inside the frame sides.
- H. Shaft Bearings: One of the following as recommended by manufacturer for the application:
  1. Oil impregnated sintered bronze.
  2. Graphite impregnated nylon sleeve with thrust washers at bearings.
  3. Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.
  4. Molded synthetic bearings.
- I. Linkage Bearings: One of the following as recommended by manufacturer for the application:
  1. Oil impregnated sintered bronze
  2. Graphite impregnated nylon.
- J. Maximum Pressure Differential: 6 inches wg.
- K. Temperature Limits: -40 to 200 degrees F.
- L. Manufacturers:
  1. Greenheck.
  2. CESCO.
  3. Pottorff.
  4. Nailor.
  5. Ruskin.
- M. Reference the Damper Schedule in Part 3 for basis of design damper model and material for the application.

## 2.4 OPERATORS

- A. General:
  1. Voltage: Voltage selection shall be as required to achieve the required torque for the application.
    - a. Reference Part 3 for Damper Operator Voltage Schedule.
  2. Type: Motor operated, with or without gears. Motor type shall be continuous duty.
  3. Construction:
    - a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

- b. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
    - c. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
  - 4. Field Adjustment:
    - a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
    - b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
  - 5. Two-Position Actuators: Single direction, spring return or reversing type. End-switches shall be integral to the actuator to determine actuator status.
  - 6. Modulating Actuators:
    - a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
    - b. Control Input Signal:
      - 1) Three Point, Tristate, or Floating Point: Clockwise and counterclockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
      - 2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-Vdc or 2- to 10-Vdc and 4- to 20-mA signals.
      - 3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
    - c. Programmable Multi-Function:
      - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
      - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
  - 7. Position Feedback:
    - a. Where indicated on the control's drawings, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
    - b. Where indicated on the control's drawings, equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
    - c. Actuator shall contain position indicator and graduated scale indicating open and closed travel limits.
  - 8. Integral Overload Protection:
    - a. Provide against overload throughout the entire operating range in both directions.
    - b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
  - 9. Attachment:
    - a. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to device without the need for connecting linkages.
    - b. Attach actuator to device drive shaft in a way that ensures maximum transfer of power and torque without slippage.
  - 10. Temperature and Humidity:
    - a. Temperature: Suitable for operating temperature range encountered by application.
    - b. Humidity: Suitable for humidity range encountered by application, non-condensing.
  - 11. Enclosure:
    - a. Suitable for ambient conditions encountered by application.
    - b. NEMA 4 for indoor wash-down or wet locations.
    - c. NEMA 4X, Belimo ZS-300, or equivalent; for outdoor applications.
    - d. Provide actuator enclosure with heater and control where required by application.
  - 12. Stroke Time:
    - a. Coordinate with stroke time indicated on the control drawings.
    - b. Unless otherwise noted, select operating speed to be compatible with equipment and system operation.
- B. Damper Operators:
- 1. Controls contractor shall size damper operator.
  - 2. Sizing: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
    - a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
    - b. Provide one operator for maximum 20 sq ft damper section or maximum 7 in-lb/sq ft damper area.
  - 3. Fail Positions:

- a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection. Normal positions are indicated on the control drawings.
      - 1) Return air damper, normally open.
      - 2) Outside air damper, normally closed.
      - 3) Exhaust/Relief air damper normally closed.
    - b. Operator shall fail in place for all other applications not listed under spring return.
- C. Valve Operators
  - 1. Sizing: Select operator with sufficient torque capacity to operate the valve under all conditions and to guarantee tight shut-off of as specified against system pressure encountered.
    - a. Operators for Hydronic Control Valves: Capable of closing valve against system pump dead head.
  - 2. Fail Positions:
    - a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection.
      - 1) Other devices needing fail safe operation to account for freeze protection, power failure, overheating or moisture damage, reference control drawing points list for normal position.
    - b. Operator shall fail in place for all other applications not listed under spring return.
- D. Manufacturers:
  - 1. Damper Operators:
    - a. Belimo.
    - b. Honeywell.
    - c. Johnson Controls.
    - d. Schneider Electric (Invensys).
    - e. Siemens.
  - 2. Valve Operators:
    - a. Belimo.
    - b. Bray.
    - c. Danfoss.
    - d. Fisher Controls.
    - e. Honeywell.
    - f. Johnson Controls.
    - g. Schneider Electric (Invensys).
    - h. Siemens.

## 2.5 FLOW MEASURING APPARATUS

- A. Water Flow Meter: Provide Water Flow Meter as specified in Division 23 Section, "Meters and Gauges for HVAC Piping."

## 2.6 INPUT/OUTPUT SENSORS AND TRANSMITTERS

- A. General:
  - 1. Performance Requirements:
    - a. Device must be compatible with project DDC controllers.
    - b. Elements used shall be general-purpose type.
    - c. Provide transmitters or transducers with sensors as required, with range suitable for the system encountered.
      - 1) Transmitters and transducers shall have offset and span adjustments.
      - 2) Shock and vibration shall not harm the transmitter or transducer.
      - 3) Transmitters and transducers shall have a zeroing capability of readjusting the transmitter zero.
    - d. Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.
  - 2. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal.
  - 3. Input Power: Low voltage, nominal 24 Vdc.
- B. Temperature Sensors:
  - 1. General: Temperature sensing elements shall have characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy. Sensor shall be UL 873 listed for temperature equipment.
  - 2. Performance Requirements:
    - a. Thermistor:
      - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
      - 2) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

- 3) Resolution: Plus/minus 0.2 degrees F minimum.
  - 4) Heat Dissipation Constant: 2.7 mW per degree C.
  - 5) Drift: 0.04 degree F after 10 years within temperature range.
  - b. RTD:
    - 1) Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
    - 2) Accuracy (All): Plus/minus 1 degree F minimum, unless otherwise noted below.
      - a) Room Sensor Accuracy: Plus/minus 0.5 degrees F minimum.
      - b) Chilled Water Accuracy: Plus/minus 0.5 degrees F minimum.
      - c) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.
    - 3) Resolution: Plus/minus 0.2 degree F.
    - 4) Drift: 0.04 degrees F after 10 years within temperature range.
  - c. Sensing Range:
    - 1) Provide limited range sensors if required to sense the range expected for a respective point.
  - d. Wire Resistance:
    - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
    - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
  3. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
  4. Room Temperature Sensors:
    - a. Construct for surface or wall box, or enclosure with insulated backing suitable for exterior wall mounting.
    - b. Provide the following features:
      - 1) Setpoint reset slide switch, dial wheel, or push-button interface with an adjustable temperature range.
      - 2) Individual heating/cooling setpoint slide switches, dial wheel, or push-button interface.
      - 3) Momentary override request push button for activation of after-hours operation.
      - 4) Integral digital display with the following:
        - a) Indication of space temperature.
        - b) Setpoint adjustment to accommodate room setpoint.
        - c) Manual occupancy override and indication of occupancy status.
        - d) Controller mode status.
  5. Temperature Averaging Elements:
    - a. Use on duct sensors for ductwork 10 sq ft or larger.
    - b. Use averaging elements where prone to stratification with sensor length range between 16-22 ft.
    - c. Provide for all mixed air and heating coil discharge sensors regardless of duct size.
  6. Insertion Elements:
    - a. Use in ducts not affected by temperature stratification or smaller than 10 sq ft.
    - b. Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches for pipe sizes greater than 4 inches.
    - c. Immersion Well Housing: 1/2 inch NPT brass or stainless steel. Stainless steel required for piping 6 inch and larger.
- C. Humidity Sensors:
1. Elements: Accurate within 3 percent full range with linear output.
    - a. Accuracy shall include temperature effects.
  2. Resolution: Plus/minus 1 percent.
  3. Drift: Less than 1 percent full scale per year.
  4. Sensing Range: 0 to 100 percent relative humidity.
  5. Room Sensors: Provide housing with integral sensor. Housing shall be plastic, NEMA 250, Type 1. Provide with insulated backing suitable for exterior wall mounting.
    - a. Cover: Provide display indicating sensed humidity value.
  6. Duct Sensors: Insertion type probe with mounting plate. Housing shall be metal, NEMA 250, Type 1.
  7. Outside Air Sensors: With element guard and mounting plate.
- D. Pressure Transmitters:
1. Duct Static Pressure:
    - a. Type: Unidirectional, fixed range.
    - a. Performance Characteristics:
      - 1) Accuracy: Plus/minus one percent of full scale.
      - 2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.

- 3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.
- 4) Long Term Thermal Stability: Plus/minus one percent full scale per year.
- b. Construction:
  - 1) Insertion or traverse type sensor suitable for use in flat oval, rectangular, and round duct configurations.
  - 2) Insertion length selected as appropriate for duct size.
  - 3) Traverse sensors shall have at least one pickup point every 6 inches.
  - 4) Element: Variable capacitance sensing technology.
  - 5) Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.
2. Space Static Pressure:
  - a. Type: Bi-directional, fixed range.
  - b. Performance Characteristics:
    - 1) Accuracy: Plus/minus 0.5 percent of full scale.
    - 2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.
    - 3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.
    - 4) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.
  - c. Construction:
    - 1) Sensing Port Wall Mounting: Wall plate with integral sensor, sized to fit standard single gang electrical box. Back of sensor plate fitted with union fitting for tubing connection.
    - 2) Sensing Port Ceiling Mounting: Round plate with union fitting for tubing connection.
    - 3) Sensor Element: Variable capacitance sensor technology.
    - 4) Sensor Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.
3. Hydronic Pressure:
  - a. Type: Unidirectional, fixed range.
  - a. General Sensor Performance Characteristics:
    - 1) Accuracy: Plus/minus 1.0 percent of full scale.
    - 2) Thermal Effects: Temperature compensated minimum 30 to 150 F range. Zero and span shift of plus/minus 0.02 percent or less of full scale per degree F.
    - 3) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.
    - 4) Range: Select sensor so that the scheduled differential pressure setpoint is near the midrange of the sensor pressure range.
  - b. Performance Characteristics for Chiller/Boiler Equipment Differential Pressure:
    - 1) Application: Variable-Primary Flow Systems.
    - 2) Accuracy: Plus/minus 0.05 percent of full scale.
    - 3) Thermal Effects: Temperature compensated minimum 30 to 150 F range. Zero and span shift of plus/minus 0.02 percent or less of full scale per degree F.
    - 4) Long Term Thermal Stability: Plus/minus 0.125 percent full scale per year for minimum 5 years.
    - 5) Range: Select sensor so that the scheduled differential pressure setpoint is near the midrange of the sensor pressure range.
    - 6) Manufacturers:
      - a) Rosemount, 3051S
      - b) Approved equal.
  - c. Construction:
    - 1) Suitable for the media temperature and pressure.
    - 2) Chiller/Boiler differential sensor shall have push button zero and span adjustments. No internal mechanical linkages shall be used in the transmitter.
    - 3) Element: Diaphragm type, stainless steel.
    - 4) Housing: Fire retardant glass-filled polyester, stainless steel, or aluminum.
- E. Equipment Operation Sensors:
  1. Status Inputs for Airside Equipment:
    - a. Type: Fixed range differential pressure switch with adjustable setpoint.
    - b. Performance Characteristics:
      - 1) Range: Not greater than two times the design fan static pressure.
    - c. Construction:
      - 1) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.
      - 2) Provide Insertion tube for use in duct configurations. Insertion length selected as appropriate for duct size.

- 3) Contact Type: Single-pole, single-throw (SPST). Provide multiple poles or throw contacts to meet additional alarms required.
2. Status Inputs for Hydronic Equipment:
  - a. Differential Pressure Switch: Fixed range type with adjustable setpoint.
    - 1) Range: Not greater than two times the design equipment differential pressure.
    - 2) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.
    - 3) Contact Type: Single-pole, single-throw (SPST). Provide double-throw contacts to meet additional alarms required.
  - b. Flow Switch:
    - 1) Thermal dispersion flow switch enclosed in insertion device, of material suitable for fluid encountered and magnetic setpoint coordinated with the desired flow rate.
      - a) Range: Sensitivity suitable for the maximum and minimum design flow rates of the system in which it is installed.
      - b) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered, with LED status indicators for visual switch indication.
      - c) Contact Type: Automatic reset upon regain of flow.
3. Status Inputs for Electric Motors:
  - a. Analog Current Transducer:
    - 1) Type: Split core design, cable of being installed or removed without dismantling the primary bus cables.
    - 2) Performance Characteristics:
      - a) Accuracy: Plus/minus 2 percent of selected range.
      - b) Range: Multi-range device, suitable for the amperage encountered with internal zero and span adjustment.
      - c) Analog output signal: Generate a proportional control signal relative to the amount of current through the primary bus cables.
    - 3) Construction:
      - a) 24 V or Self-powered (passive).
      - b) Provide with integral command relay.
      - c) Device shall accept overcurrent up to twice its trip into range.
      - d) Enclosure: UL 94 approved thermoplastic, rated for V-0. No metal parts shall be exposed other than the terminals.
  - b. Binary Current Sensing Relay:
    - 1) Type: Split core with current transformers, adjustable and set to 175 percent of rated motor current.
    - 2) Self-powered (passive) with solid-state circuitry and a dry contact output.
    - 3) Adjustable trip point.
    - 4) Contact Type: Single-pole, double-throw (SPDT).
    - 5) LED indicating the on or off status.
    - 6) A conductor of the load shall be passed through the window of the device.
    - 7) Device shall accept overcurrent up to twice its trip into range.

**F. Leak Detection Sensors**

1. Leak detection sensors shall be stand alone as described in Division 23 Section, Common Work Results for HVAC". Monitor leak detection sensors as noted on the drawings.

**G. Carbon Dioxide Sensors:**

1. General: Provide non-dispersive infrared (NDIR) CO2 sensors with integral transducers and linear output.
  - a. Linear, CO2 Concentration Range Display: 0 to 2000 ppm.
  - b. Full Scale Accuracy: Plus/minus 75 ppm at concentrations of both 600 and 1,000 ppm when measured at sea level at 77 degrees F.
  - c. Maximum Response Time: 1 minute.
  - d. Analog Output: 0-10 Vdc or 4-20 mA.
  - e. Rated Ambient Conditions:
    - 1) Air Temperature: Range of 32 to 122 degrees F.
    - 2) Relative Humidity: Range of 0 to 95 percent (non-condensing).
2. Calibration Characteristics:
  - a. Factory calibrated and certified by the manufacturer to require calibration not more frequently than once every 5 years.
  - b. Automatically compensating algorithm for sensor drift due to sensor degradation.
  - c. Sensor shall be temperature compensated throughout entire operating range.
  - d. Maximum Drift: 2 percent per year.

3. Construction:
  - a. Sensor Chamber: Non-corrosive material for neutral effect on carbon dioxide sample.
  - b. Duct Mounting: Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
  - c. Wall/Surface Mounting: Construct for surface or wall box or enclosure suitable for wall mounting.

## 2.7 OUTPUT CONTROL DEVICES

- A. Control Relays:
  1. Provide relay with contact rating, configuration, and coil voltage that is suitable for the application.
  2. Provide NEMA 1 enclosure when relay is not installed in a local control panel.
  3. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator.
  4. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus/minus 200 percent minimum from setpoint.
- B. Fan Speed Controllers:
  1. Solid-state model providing field-adjustable proportional control of motor speed. Equip with filtered circuit to eliminate radio interference.

## 2.8 POWER SUPPLIES

- A. Reference Division 23 Section "Direct Digital Controls for HVAC" for DC power supply requirements.
- B. Control power transformers shall meet NEMA/ANSI standards.
- C. Control power transformers shall be UL listed for Class 2 current-limited service or provided with over-current protection on both primary and secondary circuits for Class 2 current-limited service.
- D. Connected load on the transformer shall not exceed 80 percent of the transformer's rated capacity.
- E. The core and windings shall be completely encased in a UL approved thermoplastic. No metal parts shall be exposed other than the terminals.
- F. Performance Characteristics:
  1. Accuracy: Plus/minus 1 percent at 5.0 A full scale output.
- G. Provide a disconnect switch for each transformer.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

### 3.2 INSTALLATION

- A. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.



B. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
3. Install all equipment in readily accessible locations.
4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
5. Install all products in accordance with manufacturer's instructions.

C. Sensors:

1. Mount sensors rigidly and adequately for the environment within which the sensor operates.
2. Provide thermistor type temperature sensors for temperature ranges between minus 30 degrees F to 230 degrees F. Provide RTD type temperature sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
3. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Coordinate installation of room/space sensors with architect and other trades to ensure a neat and orderly installation.
4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
5. Sensors used in mixing plenums and hot and cold decks shall be of averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
6. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each square foot of coil area.
7. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10 feet downstream.
8. Install temperature, humidity, and smoke detectors for both supply air and return air applications a minimum of 10'-0" downstream or upstream of the air handling unit and prior to any branch duct takeoffs.
9. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
10. Install outdoor air temperature sensors on north wall, complete with sun shield where shown on the plans. If not shown, locate sensors in an accessible location, a minimum of 15 feet away from exhaust or relief air locations.
11. Adjust flow switch to meet sensitivity required to ensure minimum flow through the equipment.
12. Verify location and mounting height of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Align with adjacent lighting switches and humidistats.
  - a. Install devices to meet ADA requirements unless otherwise noted on the plans.
13. Mount freeze protection thermostats using flanges and element holders.
  - a. Install thermostat completely across the surface the thermostat serves.
14. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
15. Provide separable sockets for liquids and flanges for air bulb elements.
16. Provide guards on thermostats in areas indicated on the drawings.
17. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
18. Install shutoff valves in the high- and low-pressure reference lines connecting to hydronic pressure sensors and switches. Install a shunt valve across the high and low reference pressure ports for servicing. Valves may be ordered as an integral option with the sensor.

D. Control Valves:

1. Do not install brass valves in open-loop systems.
2. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
3. Install flanges or unions to allow valve removal and installation.
4. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
5. Valve Orientation:
  - a. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
  - b. Install valves in a position to allow full stem movement.
  - c. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.
6. Provide valves with position indicators where sequenced with other controls.

7. Tag valves in accordance with Division 23 Section, "Identification for HVAC Piping and Equipment."
  8. Install a pressure/temperature port on each side of pressure independent control valves (PICVs) which are not factory provided with integral ports.
- E. Control Dampers:
1. Install dampers with extruded aluminum or stainless steel frames and blades in corrosive environments and areas with high humidity.
  2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
  3. Clearance:
    - a. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
    - b. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
  4. Service Access:
    - a. Dampers and actuators shall be accessible for visual inspection and service.
    - b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23 Section, "Air Duct Accessories."
  5. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting.
  6. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
  7. Provide mixing dampers of parallel blade construction arranged to mix streams. Where shown on the drawings, provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.
  8. Provide isolation (two position) dampers of parallel blade construction.
  9. Provide opposed blade damper configuration for all other applications.
  10. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
  11. After installation of low-leakage dampers and seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.
- F. Operators:
1. Mount and link control damper actuators according to manufacturer's instructions.
    - a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.
    - b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
    - c. Provide all mounting hardware and linkages for actuator installation.
  2. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.
  3. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer.
- G. Control Panels:
1. Install control panels where shown on the drawings and where required to house controllers for the controlled systems and equipment.
  2. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
  3. Coordinate 120V power requirements with Division 26 to panels used for the building automation system and transformers for low voltage power to controllers.
- H. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- I. Provide an insulation standoff on control devices, cables, and other items that do not require flush mounting to ductwork, piping, or equipment.

### 3.3 MAINTENANCE

- A. Refer to Division 01 closeout requirements for additional requirements relating to maintenance service.
- B. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

### 3.4 STARTUP AND DEMONSTRATION

- A. Control Dampers and Valves:
  - 1. Stroke and adjust control valves and dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
  - 2. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
  - 3. For control valves and dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
  - 4. Verify that all two-position dampers and valves operate properly and that the normal positions are correct.
  - 5. Verify that all modulating dampers and valves are functional, that the start and span are correct, that direction and normal positions are correct, and that they achieve proper closure.

### 3.5 DAMPER SCHEDULE

Service	Ruskin Model	Material
Outside, Exhaust and Relief		
Air Control, Stairway and Shaft Vents	CD-50	Aluminum
Fire/Smoke Damper for Smoke Control	FSD-60	Galvanized Steel
Smoke Damper for Smoke Control	SD-60	Galvanized Steel
All Other	CD-356	Galvanized Steel

### 3.6 DAMPER OPERATOR VOLTAGE SCHEDULE

Service	Voltage
Interlocked with HVAC fans	120V
Multi-section dampers	120V
Large dampers (> 60 inches in any dimension)	120V
All other operators control wiring	24V

- A. Note: Coordinate with Division 26 if 120V power is required for operator to achieve appropriate torque requirements for damper actuation.

### 3.7 CONTROL VALVE SCHEDULES

- A. Allowable Valve Type and Size by Control Application:

Valve Type	Control Application	
	Modulating	Two-Position
Globe	≤ 4 in	≤ 2 in
Characterized Ball	≤ 4 in	≤ 4 in
Butterfly	> 4 in	≥ 2-1/2 in

- B. Allowable Valve Body Material by Service Application:

Valve Body Material	Service Application	
	Closed Loop	Open Loop
Bronze	Allowed	Allowed
Brass	Allowed	Not Allowed
Iron	Allowed	Allowed
Stainless Steel	Allowed	Allowed

- C. Allowable End Connection by System Material:

- 1. Copper Tube:
  - a. 2-1/2 Inch and smaller: Threaded ends.
- 2. Steel Pipe:
  - a. 2 Inch and Smaller: Threaded.

- b. 2-1/2 Inch and Larger:
- 1) Flanged.
  - 2) Grooved ends for water systems.

D. Allowable End Connection by Size Schedule:

Valve Type	<u>End Connection Type</u>		
	Threaded	Flanged	Grooved
Globe	≤ 2-1/2 in	≤ 4 in	n/a
Characterized Ball	≤ 2-1/2 in	≤ 3 in	n/a
Butterfly	N/A	≥ 2-1/2 in	≥ 2-1/2 in

**END OF SECTION 230913**

## **SECTION 230923**

### **DIRECT DIGITAL CONTROL FOR HVAC**

#### **PART 1 - GENERAL REQUIREMENTS**

##### **1.1 SECTION INCLUDES**

- A. New mechanical equipment shall be integrated into existing BMS system. Coordinate with owner and district's control contractor contact for any additional modifications and additions required for new work based on contract documents.

#### **PART 2 - PRODUCTS AND MATERIALS**

##### **2.1 SYSTEM DESCRIPTION**

- A. Refer to the drawings for specification of the building automation control equipment and sequences associated with the equipment.

#### **PART 3 - EXECUTION**

##### **3.1 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Coordination:
  - 1. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

##### **3.2 STARTUP AND DEMONSTRATION**

- A. Control system shall be set up and checked by factory trained technicians skilled in the setting and adjustment of the equipment used in this project. Technician shall be experienced in the type of HVAC systems associated with this project.
- B. At the completion of the startup, this contractor shall demonstrate the sequence of operations for each system to the Architect, Owner, or their representative.

##### **3.3 TRAINING**

- A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of eight hours on the operation and maintenance of the equipment provided under this section.
- B. Content: Training shall include but not be limited to:
  - 1. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
  - 2. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
- C. Schedule: Schedule training with Owner with at least 7 days' advance notice.

#### **END OF SECTION 230923**



## **SECTION 232113 - HYDRONIC PIPING**

### **PART 1 - GENERAL**

#### 1.1 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Hydronic piping materials.
- C. Hydronic piping fittings.
- D. Hydronic piping joining materials.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

#### 1.3 SUBMITTALS

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Reference Division 23 Section, "Basic Piping Materials and Methods" for additional submittal requirements.
- C. Reports as specified in Part 3 of this Section.

#### 1.4 QUALITY ASSURANCE

- A. Comply with Division 23 Section, "Basic Piping Materials and Methods."
- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this Section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this Section, with minimum three years of documented experience.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Division 23 Section, "Basic Piping Materials and Methods."

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 HYDRONIC PIPING MATERIALS

- A. Carbon Steel Pipe:
  - 1. NPS 2 inch and Smaller: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain ends.
  - 2. NPS 2-1/2 inch through 10 inch: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain or beveled ends.
- B. Copper Tubing:
  - 1. Drawn Temper Tubing: ASTM B88, Type L.

## 2.2 HYDRONIC PIPING FITTINGS:

- A. General: Fittings shall be of wall thickness, pressure rating, and material matching adjoining pipe.
- B. Reference Division 23 Section "Basic Piping Materials and Methods" for basic piping materials and fittings.
- C. Threaded:
  - 1. All threads shall conform to ASME B1.20.1.
  - 2. Malleable-Iron: ASME B16.3, standard pattern.
  - 3. Cast-Iron: ASME B16.4, standard pattern.
- D. Flanged:
  - 1. Cast-Iron Threaded: ASME B16.1, raised ground face, bolt holes spot faced.
  - 2. Cast-Bronze Flanges: ASME B16.24, raised ground face, bolt holes spot faced.
  - 3. Wrought Cast-Iron, Forged Steel, and Stainless Steel: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connection, and facing:
    - a. Material Group: 1.1.
    - b. End Connections: Butt welding.
    - c. Facings: Raised face.
  - 4. Gaskets: ASME B16.21, non-metallic, asbestos free, 1/8 inch thick, full-face for cast-iron flanges and raised-face steel flanges, suitable for chemical and thermal conditions of piping system contents.
  - 5. Flange bolts and nuts: ASME B18.2.1, hex head carbon steel according to ASTM A307, Grade B.
- E. Welded:
  - 1. Carbon and Galvanized Steel: ASME B16.9, seamless weld conforming to ASTM A234.
- F. Solder-Joint: Wrought-copper, ASME B16.18 or B16.22, streamlined pattern.
- G. Brazed-Joint: Wrought-copper, ASME B16.50, streamlined pattern.
- H. Transition Fittings for plastic to metal piping shall be of the plastic material of the adjoining pipe, one-piece, with a threaded brass or copper insert and schedule 80 solvent cement or fusion end.

## 2.3 HYDRONIC PIPING JOINING MATERIALS:

- A. Reference Division 23 Section "Basic Piping Materials and Methods" for basic joining materials.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Install piping to ASME B31.9 requirements.
- C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.
- D. Do not install PVC or non-plenum rated CPVC piping in return air plenums.

### 3.2 PIPE APPLICATION SCHEDULE

- A. Heating Hot Water Piping, Above Grade:
  - 1. Acceptable Pipe Materials:
    - a. Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
    - b. Type L copper with soldered, brazed, or flanged fittings.
    - c. Stainless steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
  - 2. Fitting Pressure Class: Minimum rating of 150 psig.



- B. Chilled Water Piping, Above Grade:
  - 1. Acceptable Pipe Materials:
    - a. Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
    - b. Type L copper with soldered, brazed, or flanged fittings.
    - c. Stainless steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
  - 2. Fitting Pressure Class: Minimum rating of 150 psig.
- C. Condensate Drain Piping:
  - 1. Acceptable pipe materials for piping located inside the building:
    - a. Type DWV copper with soldered fittings for piping 1-1/4 inch and larger.

### 3.3 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment using jointing system specified.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

### 3.4 PIPING INSTALLATION

- A. Provide long radius elbows with a minimum centerline radius of 1-1/2 times the pipe diameter. Short radius elbows with a minimum centerline radius of 1 times the pipe diameter may be used only where space does not permit the long radius elbows.
- B. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.
- C. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
- D. Install branch connections to mains using Tee fittings in main with take-off out the top or side of the main unless otherwise shown on the drawings. Up-feed risers shall have take-off out the top of the main line.
  - 1. Tee-drilling is prohibited as a means for connecting branch taps into any main.
  - 2. Bull-head tees are prohibited. Do not install tee fittings in such a way that the flow through the branch leg equals the sum of the flows through the two main legs.
- E. Anchor piping to ensure proper direction of expansion and contraction.
- F. Minimum condensate pipe size shall be 3/4 inch unless otherwise noted on plans.
- G. Terminate condensate piping outside the building at nearest drain or other location as shown on the plans with air gap.

### 3.5 PIPE HANGERS AND SUPPORTS APPLICATION

- C. Comply with the requirements of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- A. Provide vibration isolation on piping as specified in Division 23 Section "Vibration Isolation for HVAC."
- B. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	1/2

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
2-1/2	11	9	1/2
3	12	10	1/2
4	14	12	5/8 (1/2 for copper)
5	16	13	5/8 (1/2 for copper)
6	17	14	3/4 (5/8 for copper)
8	19	16	7/8 (3/4 for copper)
10	20	18	7/8 (3/4 for copper)
12	23	19	7/8 (3/4 for copper)
14	25		1
16	27		1
18	28		1 1/4
20	30		1-1/4
24	32		1-1/4
30	33		1-1/4

- C. Use copper tube maximum hanger span requirements for PVC and CPVC supports and hangers, unless manufacturer's recommendations specify closer hanger spacing.
- D. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.
- E. Install a support within one foot of each change of direction.
- F. Space supports not more than five feet apart at valves, strainers, or piping accessories in piping larger than 2 inches.

### 3.6 PIPE JOINT CONSTRUCTION

- A. Reference Division 23 Section, "Basic Piping Materials and Methods" for basic pipe joint construction.
- B. Where more than one pipe material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
- C. Install non-conductive dielectric connections whenever joining dissimilar metals.
- D. Pipe-to-Valve and Pipe-to-Equipment Connection: Install flanges or unions between piping and valves and equipment for servicing. Do not use direct welded, brazed, or soldered connections unless specifically called for in the manufacturer's installation instructions.

### 3.7 FIELD QUALITY CONTROL

- A. Preparation for Testing:
  1. Prepare hydronic piping in accordance with ASME B31.9.
  2. Leave joints, including welds, uninsulated and exposed for examination during the test.
  3. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
  4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
  5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Pressure Testing:
  1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
  2. Use vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system. Use drains installed at low points for complete removal of the liquid.
  3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
  4. Subject piping system to a hydrostatic test pressure which at every point in the system is 1.5 times the maximum system design pressure but not less than 100 psi. The test pressure shall not exceed the maximum

- pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix I of ASME B31.9, Code For Pressure Piping, Building Services Piping.
5. After the hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leaks. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
  6. Provide test reports summarizing the test procedures and results of the tests.
- C. Flushing:
1. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 FPS through all portions of the system.
  2. Make all provisions required to isolate HVAC equipment, coils, control valves, automatic flow control valves, pressure independent control valves, and balance valves during flushing.
  3. Isolate new pipe from existing pipe during flushing.
  4. Provide temporary valves, connections, and bypasses where required.
  5. System pumps may be used for flushing. Where system pumps are not used, provide temporary pumps with temporary connections.
  6. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials.
  7. Upon completion of flushing, drain all water from system at low points, and remove, clean, and replace strainers.
  8. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.
- D. Fluid Testing: After filling the system as described under Paragraph "Startup", perform the following fluid test procedures:
1. Circulate the fluid for a minimum of 24 hours with all pumps operating and with shutoff valves and control valves in wide open position to ensure thorough mixing of the antifreeze or glycol solution throughout the system.
  2. Remove fluid from a minimum of three different locations and test fluid samples at an independent testing agency for percentage of antifreeze or glycol. Coordinate with the testing agency for amount of sample needed for proper testing.
  3. If any sample does not meet the specified percentages, remove sufficient fluid from the system, add antifreeze or glycol as required to achieve the specified percentage and repeat the circulation and testing procedures specified above. Coordinate with the water treatment supplier.
  4. After the samples meet the specified percentages, submit to the Owner and Engineer signed and dated test report(s) from independent testing agency that document the location of the sample and the results of the fluid test.
  5. One month prior to end of the warranty period, Contractor shall submit samples to an independent testing agency to test the fluid for percentage of antifreeze or glycol. If the test samples have the specified percentage, submit copies of the test reports to the Owner and Engineer as described above in Paragraph 4. If any sample does not meet the specified percentage, Contractor shall perform the work described above in Paragraphs 3 and 4.

### 3.8 ADJUSTING AND CLEANING

- A. After installation of entire system, fill, clean, and treat systems. Refer to Section 232500 HVAC Water Treatment for additional requirements.
- B. Cleaning Agent Concentration:
1. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.
- C. Hot Water Heating Systems:
1. Apply heat while circulating, slowly raising temperature to 160 F and maintain for 12 hours minimum.
  2. Remove heat and circulate to 100 F or less, drain systems as quickly as possible.
  3. Refill with clean water and circulate for 6 hours at design temperatures, then drain.
  4. Refill with clean water and repeat until system cleaner is removed.
- D. Chilled Water Systems:
1. Circulate for 48 hours, then drain systems as quickly as possible.
  2. Refill with clean water, circulate for 24 hours, then drain.
  3. Refill with clean water and repeat until system cleaner is removed.

- E. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.
- F. Remove and clean or replace strainer screens.
- G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- H. After cleaning system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- I. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- J. Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- K. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

### 3.9 STARTUP

- A. Fill system and perform initial chemical treatment. For systems with antifreeze or glycol, fill systems with specified percentages. Refer to Division 23 Section "HVAC Water Treatment" for chemical treatment.
- B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
  - 1. Open valves to full open position. Close coil bypass valves.
  - 2. Remove and clean strainers.
  - 3. Set automatic fill valves for required system pressure.
  - 4. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
  - 5. Set temperature controls so all coils are calling for full flow.
  - 6. Check operation of automatic bypass valves.
  - 7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
  - 8. Lubricate motors and bearings.

### END OF SECTION 232113

## **SECTION 232114 - HYDRONIC SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Air vents.
- B. Strainers.
- C. Suction diffusers.
- D. Flexible connectors.
- E. Balancing valves.
- F. Relief valves.
- G. Pressure reducing valves.
- H. Combination Piping Packages (Coil Kits).

#### **1.2 SUBMITTALS**

- A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.
- B. Product Data: Include rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, component sizes, rough-in requirements, service sizes, and finishes.
  - 1. Balancing Valves and Diverting Fittings: Include flow and pressure drop curves based on manufacturer's testing.
- C. Water Filtration System: Include piping layout and assembly drawings of cooling tower basin sweeper systems. Include all dimensions, piping, water jets, couplings, valves, pressure gauges, and other components required to assemble the complete sweeper system inside the cooling tower basin.
- D. Certificates:
  - 1. Inspection certificates for pressure vessels for compliance with ASTM and ANSI manufacturing standards.
  - 2. Welders' certificates complying with the requirements specified in Article, "Quality Assurance."
- E. Manufacturer's installation instructions.
- F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list for inclusion in Operating and Maintenance manual.

#### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Comply with ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
- C. Fabricate and stamp air separators, air and dirt separators, expansion tanks, and buffer tanks to comply with ASME BPVC-VIII-1.
- D. Comply with ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.
- E. Comply with AWWA Standards for governing filter media; American Water Works Association, Current Edition.

- F. Hydronic specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

### **PART 2 - PRODUCTS**

#### 2.1 AIR VENTS

- A. Manufacturers:
  - 1. American Wheatley.
  - 2. Amtrol, Inc.
  - 3. Armstrong International.
  - 4. Bell & Gossett; Xylem.
  - 5. John Wood Company.
  - 6. Nexus Valves.
  - 7. Spirax Sarco.
  - 8. Taco, Inc.
- B. Manual Type: Bronze body and nonferrous internal parts; working pressure as defined by the ANSI fitting class of the system, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge and inlet connections.
- C. Automatic Type: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; working pressure as defined by the ANSI fitting class of the system, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection.

#### 2.2 STRAINERS

- A. Y-Strainers
  - 1. Manufacturers:
    - a. American Wheatley.
    - b. Armstrong International.
    - c. Hoffman Specialty; Xylem.
    - d. Keckley.
    - e. Metraflex Co.
    - f. Mueller Steam Specialties.
    - g. Spirax Sarco.
    - h. Nexus Valve.
    - i. Watts Water Technologies.
  - 2. Pressure Rating: Rated for working pressure as defined by the ANSI fitting class of the system.
  - 3. Size 2 inch and Smaller:
    - a. Body:
      - 1) Bronze, ASTM B62.
      - 2) Forged brass ASTM B283.
      - 3) Cast iron ASTM A126 Class B.
      - 4) Type 304 stainless steel ASTM A240.
    - b. Ends: Threaded.
    - c. Cover: Screwed.
    - d. Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.
  - 4. Size 2-1/2 inch and Larger:
    - a. Body:

- 1) Cast iron, ASTM A126 Class B.
  - 2) Carbon steel ASTM A216 Grade WCB.
  - 3) Type 304 stainless steel ASTM A240.
  - b. Ends: Flanged or grooved.
  - c. Cover: Bolted.
  - d. Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.
- B. Tee Strainers
1. Manufacturers:
    - a. Keckley
    - b. Mueller Steam Specialties.
  2. Pressure Rating: Rated for working pressure as defined by the ANSI fitting class of the system.
  3. Body:
    - a. Carbon steel ASTM A216 or A234.
    - b. Type 304 stainless steel ASTM A240.
  4. Ends: Welded or Flanged.
  5. Cover: Bolted.
  6. Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.
- C. Simplex Basket Strainers
1. Manufacturers:
    - a. American Wheatley.
    - b. Keckley.
    - c. Metraflex Co.
    - d. Mueller Steam Specialties.
    - e. Watts Water Technologies.
  2. Pressure Rating: Rated for working pressure as defined by the ANSI fitting class of the system.
  3. Body:
    - a. Cast iron ASTM A126.
    - b. Carbon steel ASTM A53.
    - c. Type 304 or 316 stainless steel ASTM A240.
  4. Ends: Flanged.
  5. Cover: Bolted.
  6. Basket Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.
- D. Duplex Basket Strainers
1. Manufacturers:
    - a. American Wheatley.
    - b. Keckley.
    - c. Mueller Steam Specialties.
  2. Pressure Rating: Rated for working pressure as defined by the ANSI fitting class of the system.
  3. Materials: Provide strainer with materials of same composition for each part listed.
    - a. Shell:
      - 1) Cast iron ASTM A126.
      - 2) Carbon steel ASTM A53 or A216.
      - 3) Stainless steel ASTM A312 or A351.
    - b. Tee:
      - 1) Cast iron ASTM A126.
      - 2) Carbon steel ASTM A216 or A234.
      - 3) Stainless steel ASTM A312 or A403.
  4. Ends: Flanged.
  5. Cover: Bolted.
  6. Basket Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.
  7. Accessories:
    - a. Provide four isolation valves with stainless steel trim.
    - b. Bottom blowdown capability.

## 2.3 SUCTION DIFFUSERS

- A. Manufacturers:
1. American Wheatley.
  2. Armstrong Fluid Technology.
  3. Bell & Gossett; Xylem.

4. Keckley.
  5. PACO; Grundfos Pumps Corp.
  6. Patterson Pump Co.
  7. Taco, Inc.
  8. Victaulic.
- B. Construction: Angle pattern, cast-iron body, threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger.
1. Pressure Rating: As scheduled on the drawings, minimum working pressure as defined by the ANSI fitting class of the system.
  2. Maximum operating temperature: 300 degrees F.
- C. Accessories:
1. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
  2. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head. Provide stainless steel strainer in condenser water system.
  3. Provide disposable screen (5/32 inch mesh) to fit over cylinder strainer for cleaning during startup procedures.
  4. Adjustable foot support, designed to carry weight of suction piping.
  5. Blowdown tapping in bottom; gauge tapping in side.
  6. Permanent magnet located in flow stream, removable for cleaning.

## 2.4 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections.
- B. Metal-Type:
1. Manufacturers:
    - a. American Wheatley.
    - b. Duraflex.
    - c. Flex-Hose, Inc.
    - d. Flexicraft Industries.
    - e. Flex Pipe USA
    - f. Hyspan Precision Products.
    - g. Mason Industries, Inc.
    - h. Metraflex Co.
    - i. Twin City Hose.
    - j. Unaflex, Inc.
  2. Construction:
    - a. Braided Hose: Flanged or threaded to match equipment connection, corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
    - b. Bellows: Flanged, stainless-steel bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket.
  3. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.
  4. Maximum operating temperature: 250 degrees F.
  5. Lateral Movement: Capable of accepting 3/4 inch misalignment.
- C. Rubber-Type:
1. Manufacturers:
    - a. American Wheatley.
    - b. Duraflex.
    - c. Flex-Hose, Inc.
    - d. Flexicraft Industries.
    - e. Flex Pipe USA.
    - f. General Rubber Corp.
    - g. Griswold Controls.
    - h. Hydronic Components Inc.
    - i. IMI Hydronic Engineering.
    - j. Mason Industries, Inc.
    - k. Mercer Rubber Co.
    - l. Metraflex Co.
    - m. Nexus Valves



- n. Nutech Hydronic Specialty Products
- o. Proco Products, Inc.
- p. Twin City Hose.
- q. Unaflex, Inc.
- 2. Construction:
  - a. Braided Hose: Threaded, CPE or EPDM inner tube, stainless steel braid, stainless steel ferrules, brass or steel end connections.
  - b. Bellows Type: Flanged, fiber-reinforced EPDM rubber body with steel flanges. Do not use control rods.
    - 1) Basis of Design: Mason Industries Type SFDEJ twin sphere connection or equal.
- 3. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.
- 4. Maximum operating temperature: 250 degrees F.
- 5. Lateral Movement: Capable of accepting 3/4 inch misalignment.

## 2.5 BALANCING VALVES

- A. Manufacturers:
  - 1. American Wheatley.
  - 2. Armstrong Fluid Technology.
  - 3. Bell & Gossett; Xylem.
  - 4. Caleffi.
  - 5. Griswold Controls.
  - 6. Hays Fluid Controls.
  - 7. Hydronic Components Inc.
  - 8. IMI Hydronic Engineering.
  - 9. Nexus Valve.
  - 10. Nibco Inc.
  - 11. Nutech Hydronic Specialty Products
  - 12. Oventrop.
  - 13. Pro Hydronic Specialties.
  - 14. Taco, Inc.
  - 15. Victaulic Company of America.
- B. Construction: Provide balancing valve with fixed orifice flow balancing, flow measurement, and shut-off capabilities, memory stops, and minimum of two differential pressure metering ports.
  - 1. Quarter Turn: Provide ball or butterfly quarter turn style for measurement use in variable flow applications.
  - 2. Full Turn: Provide plug or globe, full or multiple turn style for balancing use in constant flow applications.
  - 3. Size 2 inch and Smaller: Bronze, forged brass or DZR forged brass body, threaded connections.
  - 4. Size 2-1/2 inches and Larger: Cast iron, carbon steel, or ductile iron body, with flanged or grooved connections.
  - 5. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.
  - 6. Maximum operating temperature: 250 degrees F.
- C. Accessories: Valve shall include integral pointer and calibrated scale to register degree of valve opening, with position indication readout for repeatable regulation and control.

## 2.6 RELIEF VALVES

- A. Manufacturers:
  - 1. American Wheatley.
  - 2. Armstrong International.
  - 3. Bell & Gossett; Xylem.
  - 4. Caleffi.
  - 5. Keckley.
  - 6. Spence Engineering Company, Inc.
  - 7. Spirax Sarco.
  - 8. Watts Water Technologies.
- B. Safety Relief Valves: Forged brass, bronze, or cast iron, compatible with the piping system, Teflon seat, brass or stainless steel stem, stainless steel springs, EPDM or rubber diaphragm; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code.
- C. Combined Pressure/Temperature Relief Valves: Forged brass, bronze, or cast iron, compatible with the piping system, diaphragm operated, with low inlet pressure check valve, inlet strainer removable without system shut-down,

and non-corrosive valve seat and stem. Provide with fast fill feature for filling hydronic system. Valve shall be factory-set at operating pressure and have the capability for field adjustment; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code.

- D. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.
- E. Maximum operating temperature: 250 degrees F.
- F. Opening Pressure and Capacity Setpoint: As scheduled on the drawings.

## 2.7 COMBINATION PIPING PACKAGES (COIL KITS)

- A. Combination piping packages are allowed in lieu of individual components specified for hydronic coils and devices containing hydronic coils.
- B. Components shall be same size as piping serving the unit as shown on the drawings. Control valves do not need to be same size as piping subject to the sizing requirements set forth in Division 23 "Instrumentation and Control Devices for HVAC."
- C. Package shall include the components and shall match layouts specified on the Drawings. Each component of the combination piping package shall meet the specifications for the individual components being combined.

## **PART 3 - EXECUTION**

### 3.1 HYDRONIC SPECIALTY APPLICATIONS

- A. Reference Division 23 Section "General Duty Valves for HVAC Piping" for general duty valve applications.
- B. Air Vents:
  - 1. Manual Type: High points in the system outside of mechanical rooms, at heat transfer coils, and elsewhere as required for system air venting.
  - 2. Automatic Type: Air separator outlets, expansion tank connections, high points in outlet piping of boilers and hot water heat exchangers, and elsewhere as required for system air venting within a mechanical room.
- C. Strainers: Inlet of each pressure reducing valve, pump, and elsewhere as indicated. Do not install strainers on the inlet of pumps serving open loop condenser water systems. Provide strainers in open loop condenser water system where shown on the drawings.
- D. Suction Diffusers: Install on the pump suction inlet. Do not include strainer in suction diffusers installed on pumps serving open condenser water systems, such as cooling towers. Provide strainers in open loop condenser water system where shown on the drawings.
- E. Flexible Connectors:
  - 1. Metal Type: Inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment.
  - 2. Rubber Type: Inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment.
  - 3. Omit flexible connectors if replaced by series of three grooved couplings on projects where grooved pipe is used.
- F. Balancing Valves:
  - 1. Constant Volume Pumping Systems: Where shown on the drawings and elsewhere as required to facilitate system balancing.
  - 2. Variable Volume Pumping Systems: Where shown on the drawings, sized for the smaller of the pipe size or to have a minimum pressure drop of 1 psig at the design flow rate.
- G. Relief Valves: Where located on the plans and at pressure tanks, hot water generators, low pressure side of reducing valves, heat exchangers, and expansion tanks. Install elsewhere as required by ASME Boiler and Pressure Vessel Code.

- H. Pressure Reducing Valves: Hot water generators, and elsewhere as required to regulate system pressure.

### 3.2 STRAINER SCHEDULE

- A. Acceptable strainer types based on fluid and pipe size:
  - 1. Hydronic in Pipes Smaller than 4 inch: Y-Type.
  - 2. Hydronic in Pipes Larger than 4 inch: Y-Type, T-Type, Basket.
- B. Acceptable strainer types based on orientation:
  - 1. Horizontal: Y-Type, T-Type, Basket.
  - 2. Vertical: Y-Type, T-Type.
- C. Screen Mesh Rating Based on Application:
  - 1. General Piping:
    - a. Pipe size 4 inch and smaller: 0.062 inches (12 mesh).
    - b. Pipe size larger than 4 inch: 0.125 inch (6 mesh).
  - 2. Upstream of automatic flow control valves: 0.0331 inch (20 mesh).
  - 3. Upstream of brazed plate heat exchangers: 0.0331 inch (20 mesh).
  - 4. Upstream of plate and frame heat exchangers: 0.0787 inch (10 mesh).

### 3.3 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.
- C. Air Vents:
  - 1. Where large air quantities can accumulate, provide enlarged air collection standpipes.
  - 2. Install manual air vents in piping mains with a tee fitting, 1/2 inch ball valve, threaded nipple, and cap.
  - 3. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Strainers:
  - 1. Provide valved drain and hose connection on strainer blowdown connection for strainers 2 inch and larger.
- E. Suction Diffusers:
  - 1. Adjust foot support to carry weight of suction diffuser. Install nipple and ball valve in blowdown connection.
- F. Relief Valves:
  - 1. Adjust relief valve setpoint as noted on the drawings.
  - 2. Pipe relief valve outlet to nearest floor drain.
  - 3. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

### 3.4 STARTUP

- A. Reference Division 23 Section Hydronic Piping for general startup requirements.
- B. Start up and commissioning of water filtration unit shall be performed by a factory authorized representative.
- C. Start up and commissioning of glycol makeup unit shall be performed by a factory authorized representative.
- D. Remove temporary strainer after cleaning system.

### 3.5 TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water filtration equipment and/or glycol makeup equipment.
- B. Training for Owner's personnel shall include but not be limited to:
  - 1. Overview of the system and /or equipment as it relates to the facility as a whole.
  - 2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

- C. Review manufacturer's safety data sheets for handling of chemicals.
- D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 and Division 23 Section "General Mechanical Requirements."
- E. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

**END OF SECTION 232114**

## **SECTION 232123 - HYDRONIC PUMPS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Vertical in-line, closed-coupled inline pumps.

#### **1.2 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- D. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- E. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

#### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.
- B. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.
- C. Product Options: Drawings indicate size, profiles and connections requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- D. Regulatory Requirements: Fabricate and test pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

#### **1.5 WARRANTY**

- A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting,

and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

## **PART 2 - PART 2 PRODUCTS**

### **2.1 HVAC PUMPS - GENERAL**

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Minimum Quality Standard: .
- C. Base Mounted Pumps: Aligned by qualified millwright.
- D. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.
- E. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.
- F. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.
- G. Motors: Conform to NEMA Standard MG-1, general purpose, continuous duty, Design B, except Design C where required for high starting torque; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection, and grease-lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve. Refer to Section "Common Motor Requirements for HVAC Equipment" for additional requirements.
  1. Efficiency: Motors shall have a minimum efficiency meeting the requirements of the Energy Policy Act of 1992 as defined in NEMA MG-1 when tested in accordance with IEEE Standard 112, Test Method B.
    - a. Motor Frame: NEMA Standard 48 or 54; use pump manufacturer's standard.
- H. Apply factory finish paint to assembled, tested units prior to shipping.

### **2.2 VERTICAL INLINE CLOSE COUPLED PUMPS**

- A. Type: Pumps shall be centrifugal, close-coupled, single-stage, bronze-fitted, radially split case design, with mechanical seals, for 125 psi maximum working pressure and 225 deg F continuous water temperature..
- B. Casing: Cast iron, with threaded companion flanges for piping connections smaller than 2-1/2 inches, and threaded gauge tapings at inlet and outlet connections.
- C. Impeller: Statically and dynamically balanced, closed, overhung, single-suction, cast bronze, conforming to ASTM B 584, and keyed to shaft.
- D. Shaft: Ground and polished steel shaft, with bronze sleeve and integral thrust bearing. Provide flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.
- E. TEFC Motor: Direct-mounted to pump casing; with lifting and supporting lugs in top of motor enclosure.
- F. Seal: Carbon rotating against a stationary ceramic seat, 225 degrees F maximum continuous operating temperature.
- G. Manufacturers:
  1. American Marsh Pumps.
  2. Armstrong Pumps, Inc.

3. Aurora Pumps.
4. Bell & Gossett, ITT.
5. Grundfos Pumps Corp.
6. Paco Pumps.
7. Patterson Pump Co.
8. Peerless Pump.
9. Taco, Inc.
10. Thrush Company, Inc.
11. Wilo.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

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

#### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or eccentric reducers installed flat on top. Support piping adjacent to pump such that no weight is carried on pump casings. For Vertical In-line or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge. A separate strainer is not required if a suction diffuser with strainer is provided.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Install flexible connectors on the suction and discharge side of each pump mounted on housekeeping pad. Install flexible connectors between the pump casing and the discharge valves, and upstream of the pump suction diffuser.
- H. Provide vibration isolation for pumps as specified in Section "Vibration Isolation for HVAC".
- I. Install a combination pressure gauge with tubing connected to the suction and discharge of each pump at the integral pressure gauge tapings provided as well as a tap upstream of the suction diffuser and strainer.
- J. Install temperature and pressure gauge connector plugs in suction and discharge piping around pump. Temperature and pressure gauge connector plugs are specified in Section "Meters and Gauges."
- K. Check, align, and certify alignment of base-mounted pumps prior to start-up. Comply with pump and coupling manufacturer's written instruction.
- L. Install floor mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to the drawings and Section "Vibration Isolation for HVAC" to determine where concrete inertia bases are required.
  1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."
  2. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with non-shrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.
- M. Lubricate pumps before start-up.

### 3.3 STARTUP

- A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:
  - 1. Lubricate oil-lubricated bearings.
  - 2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
  - 3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
  - 4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
  - 5. Clean strainers.
  - 6. Check piping connections for tightness.
- B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:
  - 1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
  - 2. Open the valve in the cooling water supply to the bearings, where applicable.
  - 3. Open the cooling water supply valve if the stuffing boxes are water-cooled.
  - 4. Open the sealing liquid supply valve if the pump is so fitted.
  - 5. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.
  - 6. Open the recirculating line valve if the pump should not be operated against dead shutoff.
  - 7. Start the motor.
  - 8. Open the discharge valve slowly.
  - 9. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.
  - 10. Check the general mechanical operation of the pump and motor.
  - 11. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.
- C. If the pump is to be started against a closed check valve with the discharge valve open, the steps are the same, except that the discharge valve is opened some time before the motor is started.
- D. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.
- E. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for detailed requirements for testing, adjusting, and balancing hydronic systems.

### 3.4 TRAINING

- A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.
- B. Content: Training shall include but not be limited to:
  - 1. Overview of the system and/or equipment as it relates to the facility as a whole.
  - 2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
  - 3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
- C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.
- D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

### END OF SECTION 232123



## **SECTION 233113 - METAL DUCTS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Metal ductwork.
- B. Duct liner.
- C. Duct sealants.
- D. Duct hangers and supports.
- E. Wire rope hanging system.
- F. Manufactured ductwork and fittings.

#### **1.2 DEFINITIONS**

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
  - 1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
  - 2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

#### **1.3 SYSTEM PERFORMANCE REQUIREMENTS**

- A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

#### **1.4 SUBMITTALS**

- A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
  - 1. Duct Liner.
  - 2. Sealing Materials.
  - 3. Fire-Stopping Materials.
- B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
  - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
  - 2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
  - 3. Fittings.
  - 4. Reinforcing details and spacing.
  - 5. Seam and joint construction details.
  - 6. Penetrations through fire-rated and other partitions.
  - 7. Terminal heating and cooling unit, coil, humidifier and duct silencer installations.
  - 8. Locations of fire and fire/smoke dampers and associated duct access doors.
  - 9. Locations of cleanout and access doors in grease exhaust ducts.
  - 10. Location of manual balancing dampers.
  - 11. Duct smoke detector locations. Refer to electrical drawings for general locations and coordinate locations with the electrical contractor.

- 12. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:
  - 1. Coordination with ceiling suspension members.
  - 2. Spatial coordination with other systems installed in the same space with the duct systems.
  - 3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
  - 4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.
- D. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.
- E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.
- C. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
- D. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
- E. NFPA Compliance: Comply with the following NFPA Standards:
  - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
  - 2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
  - 3. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.
- F. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Provide ductwork systems in conformance with "HVAC Duct Construction Standards – Metal and Flexible," latest edition.
- G. Underwriter's Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.
- H. National Air Duct Cleaners Association, Inc. (NADCA): Clean ductwork systems in accordance with the standard Assessment, Cleaning and Restoration of HVAC Systems (ACR 2002).

#### 1.6 PROTECTION AND REPLACEMENT

- A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.
- B. Replace duct liner that is damaged and cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installing new duct liner.

#### 1.7 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 AND MATERIALS**

### **2.1 DUCT ASSEMBLIES**

- A. Ducts: Galvanized steel, unless otherwise indicated. Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A700.
- B. Supply Air Ducts (constant volume or single zone VAV systems): 3 inches w.g pressure class, galvanized steel.
- C. Primary Supply Air Ducts (upstream of terminal boxes in multizone VAV systems): 4 inches water gauge.
- D. Secondary Supply Air Ducts (downstream of terminal boxes in multizone VAV systems): [2] inches water gauge
- E. Return and Relief: 2 inch w.g. pressure class, galvanized steel.
- F. General Exhaust: 2 inch w.g. pressure class, galvanized steel.
- G. Outside Air Intake: 2 inch w.g. pressure class, galvanized steel.
- H. Transfer Air and Sound Boots: 1/2 inch wg pressure class, galvanized steel.
- I. Duct Liner Application: Provide duct liner on the following interior air ducts and where specified on the drawings.
  - 1. Supply Ductwork:
    - a. All rectangular ductwork except OA ductwork upstream of AHU. OA ductwork upstream of AHU shall be wrapped. Refer to spec section "HVAC Insulation" for duct wrap requirements.
  - 2. Return Ductwork.
    - a. All rectangular ductwork.

### **2.2 MATERIALS**

- A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A 700.
- B. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, lock-forming quality with G90/Z275 coating.. Provide mill phosphatized or galvanized finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.
- C. Duct Liner
  - 1. General:
    - a. Comply with NFPA Standard 90A and North American Insulation Manufacturers Association (NAIMA) Standard AHC-101.
    - b. Liner shall have a flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84 or UL 723.
    - c. Duct sizes on mechanical plans indicate clear inside airflow dimensions. Sheet metal sizes for ductwork with duct liner shall be increased accordingly to account for liner thickness.
  - 2. Fiberglass: ASTM C1071, Type I or II, glass fibers firmly bonded together with a thermosetting resin with surface exposed to airstream coated to prevent erosion of glass fibers. Liner surface shall serve as a barrier against infiltration of dust and dirt, shall meet ASTM C 1338 for fungi resistance and shall be cleanable using duct cleaning methods and equipment outlined by NAIMA Duct Cleaning Guide. Duct liner shall be rated for air velocity of 6,000 fpm.
    - a. Rectangular fiberglass duct liner shall be Certainteed ToughGard T, JohnsManville Linacoustic RC, Knauf Atmosphere, Owens Corning QuietR or approved equal.
      - 1) Thickness and Density:
        - a) 1-1/2 inch, 1-1/2 pounds per cubic foot.
    - b. Thermal Performance: Meet minimum "K-Factor" equal to 0.28 (Btu-in/h-sq ft-F) or better, at a mean temperature of 75°F and rated in installed condition in accordance with ASTM C518 and/or ASTM C177.
    - c. Noise Reduction Coefficient (NRC): Meet the following minimum NRC in accordance with ASTM C423 Type A Mounting:

- 1) 1-1/2 Inch Thick: NRC 0.80.
  - d. Liner Adhesive: Comply with NFPA Standard 90A /UL 181 classified with flame spread/smoke development less than 25/50 and ASTM C 916. Adhesive shall be a minimum 50% solid content, water-based, non-oxidizing and have a service temperature of –20 to 200 F. Water-based adhesive shall be one of the following:
    - 1) Armacell LLC Armaflex 520 BLV low VOC.
    - 2) Design Polymerics DP 2502.
    - 3) Duro Dyne WIT.
    - 4) Foster 85-60.
    - 5) Childers CP-127.
    - 6) Johns Manville SuperSeal HV.
    - 7) Hardcast 951.
    - 8) United McGill Uni-Tack.
  - e. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.
    - 1) Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.
    - 2) Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.
- D. 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: Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.
  3. For Use with Flexible Ducts: UL labeled.
  4. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics. Duct tape shall not be used as a sealant on any ducts.
  5. Joint and Seam Tape: 2 inches wide, glass-fiber-reinforced fabric.
  6. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.
  7. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 70 percent solids. Approved products: Childers CP-140, Duro Dyne SGD, Fosters 32-14, or approved equal.
  8. Water-Based Joint and Seam Sealant: Non-Fibrated: UL 181 listed. Sealant shall be rated to ±15 inches w.g. Sealant shall have a service temperature of –25 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymerics DP 1010, Ductmate Proseal/Fiberseal, Duro Dyne Duroseal, Fosters 32-1, United Duct Sealer (Water Based), and Hardcast 601.
  9. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
  10. Flanged Gasket Tapes: Butyl gasket shall be UL 181 classified. Gasket size shall be minimum 5/8 inch x 3/16 inch and have nominal 100 percent solid content. It shall be non-oxidizing, non-skinning and have a service temperature of –25 to 180 F. Approved Products: Design Polymerics DP 1040, Ductmate 440, and Hardcast 1104.
- E. Fire Stopping
1. Fire-Resistant Sealant: Two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
  2. Fire-Resistant Sealant: One-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
  3. Products: Subject to compliance with requirements, provide one of the following:
    - a. "3M Fire Stop Foam"; 3M Corp.
    - b. "SPECSEAL Pensil 200 Silicone Foam"; Specify Technology, Inc.
    - c. "3M Fire Stop Sealant"; 3M Corp.
    - d. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
    - e. "Fyre Putty"; Standard Oil Engineered Materials Co.
    - f. "FS-ONE"; Hilti, Inc.

F. Hangers and Supports

1. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
2. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
  - a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
  - b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
  - c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
  - d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
  - e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
3. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
4. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
  - a. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
  - b. Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.
5. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
6. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
  - a. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
  - b. For stainless steel ducts, provide stainless steel support materials.
  - c. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.
7. Wire Rope Hanging Systems:
  - a. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
  - b. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
  - c. Wire Rope: Zinc coated or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.
  - d. Cable Lock: Cast zinc housing with steel spring with wedge grip, selected to meet the vertical load applied to the hanging system and wire thread. Do not exceed the working load limit.
  - e. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.
  - f. Manufacturers:
    - 1) ASC Engineered Solutions.
    - 2) Ductmate Industries, Inc; Clutcher Cable Hanging System.
    - 3) Duro Dyne.
    - 4) Gripple.

G. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

H. Tie Rods: Same material as the duct, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 DUCTWORK FABRICATION

- A. Fabricate and support duct in accordance with latest edition of SMACNA (DCS).
- B. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
  1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.
  2. Fabricate ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
- C. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- D. Field Painted Ductwork: Provide mill phosphatized finish on exposed surfaces of rectangular ductwork and duct fittings to be field painted.

- E. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.
- F. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.
- G. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.
- H. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer's approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section "Ductwork Accessories" for turning vane construction and mounting.
- I. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- J. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.
- K. Round and Flat Oval Duct Fabrication
  - 1. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.
    - a. Fabricate round and flat oval ductwork of minimum 26 gauge sheet metal.
- L. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.
- M. Round and Flat Oval Fittings Fabrication
  - 1. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-5, 3-6 and 3-7 and with metal thickness specified for longitudinal seam straight duct.
  - 2. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
  - 3. Elbows: Unless elbow construction type is indicated, provide elbows meeting the following requirements:
    - a. Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter.
      - 1) Elbows in Round Duct: Provide full radius elbows.
      - 2) Elbows in Flat Oval Duct: Provide full radius elbows. Where space limits the installation of full radius elbows, short radius elbows with a minimum of two continuous splitter vanes shall be installed. Vane length shall be the entire length of the bend or 36 inches whichever is greater.
      - 3) The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

- 4) Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces.
- b. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.
  - 1) Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-1.
  - 2) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:
    - a) 3 to 26 inches: 24 gauge.
    - b) 27 to 36 inches: 22 gauge.
    - c) 37 to 50 inches: 20 gauge.
    - d) 52 to 60 inches: 18 gauge.
    - e) 62 to 84 inches: 16 gauge.
  - 3) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:
    - a) 3 to 14 inches: 24 gauge.
    - b) 15 to 26 inches: 22 gauge.
    - c) 27 to 50 inches: 20 gauge.
    - d) 52 to 60 inches: 18 gauge.
    - e) 62 to 84 inches: 16 gauge.
  - 4) Flat Oval Mitered Elbows: Solid welded and with the same metal thickness as longitudinal seam flat oval duct.
  - 5) 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.
- c. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
- d. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.
- e. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
- f. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.
- g. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.
- h. Flat Oval Elbows Gauges: Same as longitudinal seam flat oval duct.
- i. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gauge.

N. Shop Application of Liner in Rectangular Ducts

1. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.
2. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
3. Butt transverse joints without gaps and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.
5. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.
  - a. Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:
  - a. Fan discharge.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where duct velocity is greater than 2,500 FPM.
8. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

## 2.4 MANUFACTURED DUCTWORK AND FITTINGS

- A. General: At the Contractor's option, factory-manufactured ductwork can be provided instead of fabricated ductwork for round and oval ductwork. The round duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer. The oval duct system shall be sealed with duct sealer as specified.
1. Ducts shall be calibrated to manufacturer's published dimensional tolerance standard.
  2. All duct 14" diameter and larger shall be corrugated for added strength and rigidity.
  3. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.
  4. Ducts shall be constructed using spiral lock seam sheet metal construction.
  5. Ductwork to be installed in exposed locations shall have the surface prepared in the factory for field painting.

B. Duct Construction

1. Unless otherwise noted, all duct and fittings shall be constructed from galvanized steel in accordance with SMACNA's Duct Construction Standards for +10" water gauge pressure with minimum wall thickness as shown in the following tables.
2. Duct shall be calibrated to manufacturer's published dimensional tolerance standard.
3. Ducts shall be constructed using spiral lock seam sheet metal construction.
4. Ductwork to be installed in exposed locations shall be factory-prepared for field painting, i.e. mill-phosphatized.

Single Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct (ga)	Galvanized Fittings (ga)
3-14	28	24
15-24	26	24
26-42	24	22
42-60	22	20

C. Fittings:

1. All fitting ends for round duct and transitions and divided flow fittings smaller than 24" diameter that convert oval duct to round duct shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to ensure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
2. All fittings shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.
3. All fitting ends from 5" to 60" diameter shall have rolled over edges for added strength and rigidity.
4. All elbows from 5" to 12" diameter shall be 2 piece die stamped and continuously stitch welded. All elbows 14" diameter and larger shall be standing seam gorelock construction and internally sealed.
5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0. The radius of all 15°, 30° and 60° elbows shall be minimum 1.0 times the elbow diameter.
6. All fittings that are of either spot welded or button punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct taps is unacceptable except for retrofit installations.
7. All volume dampers shall be Lindab Safe type DRU, DSU or DTU or equal by an acceptable manufacturer. Damper shall be fitting sized to slip into spiral duct. Damper shall have the following features:
  - a. Locking quadrant with blade position indicator.
  - b. 2" sheet metal insulation stand-off.
  - c. Integral shaft/blade assembly.
  - d. Shaft mounted, load bearing bushings.
  - e. Gasketed shaft penetrations to minimize leakage.

D. Manufacturers:

1. Hercules Industries.
2. Lewis & Lambert.
3. Lindab Safe.
4. Linx Industries, Inc.
5. Semco.



### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install products in accordance with manufacturer's instructions.
- C. Install ducts with the fewest possible joints.
- D. Seal duct joints with the appropriate sealing material.
- E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- J. Install insulated ducts with 1-inch clearance outside of insulation.
- K. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- L. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- M. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.
- N. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- O. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.
- P. Acoustical Barrier Penetrations: Where a duct passes through a wall, ceiling or floor slab of a noise critical space, provide a clear annular space of 1-inch between the duct and the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The Contractor shall check the clearance and, if clearance is acceptable, shall install the duct and pack the voids full depth with mineral fiber batt insulation. Contractor shall caulk both ends with a non-aging, non-hardening sealant backed by a polyethylene foam rod or permanently flexible firestop material. Where there is insufficient clearance space, Contractor shall place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.
- Q. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.
- R. Duct Liner Installation

1. Fiberglass Duct Liner:
    - a. Attach fiberglass duct liner using fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.
  2. Vertical Ducts:
    - a. For ducts larger than 24 inches by 24 inches, provide a 20 inch by 20 inch access opening for personnel entry at the top of the vertical riser.
    - b. For ducts smaller than 24 inches by 24 inches, provide an access opening at each floor level in a location that is accessible and not higher than 12 feet above finished floor.
    - c. Supports for ducts large enough for personnel entry shall be designed for the weight of the duct plus 800 lbs at any point in the duct system.
  3. Provide transition at connection to fan with opening size equal to or greater than the venturi opening of the fan inlet. Provide gasket at flanged connection to fan rated for 1500 F and grease applications.
  4. Do not penetrate fire-rated assemblies without providing shaft, field-applied or factory-built enclosure.
- S. 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.
- T. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- U. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- V. Seam and Joint Sealing
1. General: Seal duct seams and joints as follows:
    - a. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.
    - b. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized. Transfer air ducts and sound boots do not need to be sealed.
  2. Seal externally insulated ducts prior to insulation installation.
  3. Ductwork installed exterior to the building shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.
- W. HANGING AND SUPPORTING
1. Install rigid round, rectangular, and flat oval metal duct with support systems per SMACNA standards.
  2. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer's recommended load rating.
    - a. Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.
  3. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
  4. Support vertical ducts at a maximum interval of 16 feet and at each floor.
  5. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.
  6. Install concrete insert prior to placing concrete.
  7. Install powder actuated concrete fasteners after concrete is placed and completely cured.
  8. Provide double nuts and lock washers on threaded rod supports.
  9. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- X. Penetrations
1. Fire Barrier Penetrations: Where ducts pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.
- Y. CONNECTIONS
1. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."
  2. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards".
  3. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards". Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."
  4. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards".

### 3.2 FIELD QUALITY CONTROL

- A. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
- B. General Duct Systems: Perform leakage tests in accordance with ASHRAE and SMACNA standards.
  - 1. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.
  - 2. Conduct tests, in the presence of the Architect, at static pressures equal to the maximum design pressure of the system or the section being tested. If pressure classifications are not indicated, test entire system at the maximum system design pressure. Do not pressurize systems above the maximum design operating pressure. Give 7 days' advanced notice for testing. Submit a letter report to the Owner and Engineer summarizing the test procedures followed, systems tested and the results of the leakage tests.
  - 3. Determine leakage from entire system or section of the system by relating leakage to the surface area of the test section.
  - 4. Maximum Allowable Leakage: As described in ASHRAE 2005 Handbook, "Fundamentals" Volume, Chapter 35, Table 9 and Figure 13. Comply with requirements for leakage classification 3 for round and flat oval ducts, leakage classification 12 for rectangular ducts in pressure classifications less than and equal to 2 inches water gauge (both positive and negative pressures), and leakage classification 6 for pressure classifications greater than 2 inches water gauge and less than and equal to 10 inches water gauge.
  - 5. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
  - 6. Leakage Test: Perform volumetric measurements and adjust air systems as described in ASHRAE 2003 "HVAC Applications" Volume, Chapter 37 and ASHRAE 2005 "Fundamentals" Volume, Chapter 14, and Division 23 Section "TESTING, ADJUSTING, AND BALANCING FOR HVAC."

### 3.3 ADJUSTING, STARTUP AND CLEANING

- A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "TESTING, ADJUSTING, AND BALANCING FOR HVAC" for requirements and procedures for adjusting and balancing air systems.
- B. Vacuum duct systems prior to final acceptance to remove dust and debris.
- C. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.
- D. If permanent HVAC equipment is used during the construction period, provide temporary filters at all openings in the ductwork and at inside equipment to protect the system from dust, dirt, paint, and moisture. Replace and maintain filters when needed, but not less than every month. On the day of substantial completion, clean the duct system and provide a new set of filters in the HVAC unit.
  - 1. Refer to Division 23 Section 234100 Particulate Air Filtration for filter requirements.

### 3.4 CLEANING NEW SYSTEMS

- A. Contractor shall clean the HVAC systems in accordance with NADCA.
- B. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
- C. Use service openings, as required, for physical and mechanical entry and for inspection.
  - 1. Create other openings to comply with duct standards.
    - a. Do not degrade structural, thermal or functional system integrity of the duct.
    - b. Provide access doors complying with UL 181 to cover new openings. Refer to Division 23 Section "Air Duct Accessories".
    - c. Seal openings with tape and sealant complying with UL 181A.
  - 2. Disconnect flexible ducts as needed for cleaning and inspection.
  - 3. Remove and reinstall ceiling sections to gain access during the cleaning process.
- D. Vent vacuuming system to the outside. Provide filtration and/or containment systems to keep debris removed from HVAC systems from contaminating other spaces. Locate exhaust down wind and away from air intakes and other points of entry into building.
- E. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
  2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  4. Coils and related components.
  5. Return air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
  6. Supply and outdoor air ducts, dampers, actuators, and turning vanes.
- F. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  4. Clean fibrous-glass duct liner with HEPA vacuuming equipment while the system is under negative pressure; do not permit duct liner to get wet.
  5. Clean coils and coil drain pans according to ACR 2002. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
- G. Disposal: Debris collected from the HVAC system shall be disposed of in accordance with applicable federal, state and local requirements.
- H. Cleanliness Verification:
1. Visually inspect metal ducts for contaminants.
  2. Where contaminants are discovered, re-clean and re-inspect ducts.

**END OF SECTION 233113**

## **SECTION 233300 - AIR DUCT ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Turning vanes.
- B. Backdraft dampers.
- C. Duct access doors.
- D. Duct hardware.
- E. Fire dampers.
- F. Flexible duct connectors.
- G. Volume control dampers.
- H. Cable operated damper systems.
- I. Flexible ductwork.

#### **1.2 SUBMITTALS**

- A. Product Data: Provide for each type of ductwork accessory the following:
  - 1. Electrical characteristics.
  - 2. Connection requirements.
  - 3. Dimensions.
  - 4. Capacities.
  - 5. Pressure drops,
  - 6. Leakage rates.
  - 7. Materials of construction.
- B. Shop Drawings: Indicate for shop fabricated assemblies the following:
  - 1. Interfacing requirements with ductwork.
  - 2. Method of fastening or support.
  - 3. Methods of assembly of components.
- C. Performance Data: Submit performance data for duct silencers including insertion loss performance in octave bands from 63 Hz to 8,000 Hz and pressure drop at specified airflow.
- D. Project Record Drawings: Record actual locations of access doors and test holes.
- E. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual.

#### **1.3 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. SMACNA Compliance: Comply with applicable portions of SMACNA (DCS) "HVAC Duct Construction Standards Metal and Flexible".
- C. UL Compliance:

1. Fire Dampers: Construct, test, and label fire dampers in accordance with current edition of UL Standard 555 Standard for Fire Dampers.
  2. Smoke Dampers: Construct, test, and label smoke dampers in accordance with current edition of UL Standard 555S Standard for Smoke Dampers.
  3. Flexible Ductwork: Construct flexible ductwork in compliance with UL Standard 181 Factory-Made Air Ducts and Connections.
  4. Duct Tape: Label in accordance with UL Standard 181B and marked 181B-FX.
  5. Duct Clamps: Label in accordance with UL Standard 181B and marked 181B-C.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated
- E. NFPA Compliance:
1. Comply with applicable provisions of NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems and NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems pertaining to installation of ductwork accessories.
  2. Comply with NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations for fire-rated grease exhaust ducts.
- F. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 "Standard Test Method for Surface Burning Characteristics of Building Materials" (NFPA 255) method.
1. Duct silencers shall be tested for performance in accordance with ASTM E477 "Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers."
  2. Grease exhaust duct wrap shall be tested for performance in accordance with ASTM E 2336 "Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems" and ASTM E814 "Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops".
  3. Fire rated duct wrap shall be tested in accordance with ASTM E814 "Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops".
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Protect ductwork accessories during shipping and storage from dirt, debris and moisture damage.
  - B. Protect dampers from damage to operating linkages and blades.
- 1.5 SPARE PARTS
- A. Extra Fusible Links: One link for every 10 installed of each type, size and temperature range. Obtain receipt.

## **PART 2 - PRODUCTS**

### **2.1 TURNING VANES**

- A. Manufacturer:
  1. Aero Dyne Co.
  2. Anemostat Products Div.; Dynamics Corp. of America.
  3. Ductmate Industries.
  4. Duro Dyne Corp.
  5. Elgen Manufacturing Co., Inc.
  6. Hart & Cooley Mfg. Co.
  7. Register & Grille Mfg. Co., Inc
  8. Sheet Metal Connectors, Inc.
- B. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed.
  1. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration.

2. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened.
  3. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.
- C. Acoustical Turning Vanes: Provide acoustical turning vanes constructed of airfoil shaped aluminum extrusion with perforated faces and fiberglass fill in systems serving noise critical spaces. Refer to Section "Common Work Results for HVAC" for noise critical spaces.

## 2.2 BACKDRAFT DAMPERS

- A. Manufacturers:
1. Air Balance, Inc.
  2. Arrow United Industries.
  3. Cesco
  4. Greenheck
  5. Louvers & Dampers, Inc.
  6. Nailor Industries, Inc.
  7. Pottorff
  8. Ruskin Mfg. Co.
  9. TAMCO
  10. Vent Products
- B. Backdraft Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to open at indicated static pressure. Provide adjustment device to permit setting for varying differential static pressure
1. Construct frames of minimum 16 gauge galvanized steel or 10 gauge aluminum.
  2. Construct blades of minimum 16 gauge aluminum.
  3. Provide minimum 1/2" diameter, corrosion-resistant bearings and 1/2" diameter, galvanized or stainless steel axles.
  4. Mechanically lock blade edge seals into blade edge. Provide neoprene seals for round dampers and silicone or vinyl seals for rectangular dampers.

## 2.3 DUCT ACCESS DOORS

- A. Manufacturers:
1. Air Balance Inc.
  2. Ductmate Industries.
  3. Duro Dyne Corp.
  4. Greenheck.
  5. Register & Grille Mfg. Co., Inc.
  6. Ruskin Mfg. Co.
  7. Ventifabrics, Inc.
  8. Vent Products.
  9. Zurn Industries, Inc.; Air Systems Div.
- B. Provide, where indicated on the drawings or where specified in Part 3 of this section, duct access doors of size allowable by duct dimensions with, unless otherwise noted on the drawings, minimum size of 10" by 10" and maximum size of 24" by 24". Fabricate in accordance with SMACNA (DCS) and as indicated. Label access doors for fire and smoke dampers as specified in Part 3.
- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. Construct of same or greater gauge as ductwork served. For insulated ductwork. install minimum 1 inch thick insulation with sheet metal cover. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct.
1. 12 inches square or less: Provide one size hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors. Provide removable section of duct where duct size is too small for a 10" by 10" access door.
  2. Larger than 12 inches square: Provide two hinges and two handle-type latches.

## 2.4 DUCT HARDWARE

- A. Manufacturers:
  - 1. Ductmate Industries.
  - 2. Elgen Manufacturing Co., Inc.
  - 3. Ventfabrics, Inc.
  - 4. Young Regulator Co.
- B. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated.
  - 1. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
  - 2. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
- C. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

## 2.5 FIRE DAMPERS

- A. Manufacturers:
  - 1. Air Balance, Inc.
  - 2. Cesco Products.
  - 3. Greenheck
  - 4. Louvers & Dampers, Inc.
  - 5. Nailor Industries, Inc.
  - 6. Pottorff
  - 7. Prefco Products, Inc.
  - 8. Ruskin Mfg. Co.
- B. General: Provide fire dampers at locations indicated on the drawings. Damper ratings shall be as required to maintain the fire ratings noted on the architectural drawings. Provide duct access door for inspection and service to each fire damper and fusible link as required. Provide sleeves of length as required to meet the installed location.
- C. Fabricate in accordance with NFPA 90A and UL 555 and as indicated.
- D. Fire dampers shall be dynamic-rated for closure under pressure.
- E. Provide positive lock in closed position.
- F. Ceiling Radiation Dampers
  - 1. General: Conform to UL 555C or tested in accordance with UL 263.
  - 2. Casing: Galvanized steel frame in gauges as required to maintain applicable UL classification.
  - 3. Damper Blades: Galvanized steel with UL classified thermal insulation as required to meet UL criteria and fire and smoke ratings noted on the architectural drawings.
  - 4. Fusible link: Integral to device, rated at 165 degrees F.
  - 5. Accessories: Provide as required for the installation:
    - a. Volume Controller: Manually adjustable volume controller integral to the assembly used to regulate airflow through the damper for testing and balancing.
    - b. Boot Fitting: Factory provided elbow, end or straight type. Include field provided collar, flanged recess, or ceramic thermal blanket.
    - c. Box Fitting: Factory provided 26 gauge with field provided collar, flanged recess, or ceramic thermal blanket.
- G. Horizontal Dampers: Minimum 22 gauge galvanized steel frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket. Construct casings of 20 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.



- H. 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. Construct frames of 20-gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.
- I. Multiple Blade Dampers: Minimum 16 gauge, 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. Construct frames of 20-gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings
- J. Fusible links: UL 33 rated at 160 to 165 degrees F unless otherwise indicated.

## 2.6 FLEXIBLE DUCT CONNECTORS

- A. Manufacturers:
  - 1. Carlisle HVAC Products.
  - 2. Ductmate Industries.
  - 3. Duro Dyne Corp.
  - 4. Elgen Manufacturing Co., Inc.
  - 5. Ventfabrics, Inc.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated. Flexible connectors shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
- C. Flexible Duct Connections: Fabric crimped into metal edging strip. Provide metal compatible with connected ducts. Factory fabricated. Flame-retardant or noncombustible fabrics compliant with NFPA 701.
  - 1. Indoor Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric compliant with NFPA 90A.
    - a. Minimum Weight: 26 oz./sq. yd.
    - b. Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
    - c. Service Temperature: Minus 40 to plus 200 deg F.
  - 2. Outdoor Fabric: UL listed fire-retardant woven glass fiber fabric coated with weatherproof, synthetic rubber resistant to UV rays and ozone compliant with NFPA 90A.
    - a. Minimum Weight: 24 oz./sq. yd.
    - b. Minimum Tensile Strength: 225 lbf/inch in the warp and 300 lbf/inch in the filling.
    - c. Service Temperature: Minus 40 to plus 250 deg F.
  - 3. Metal: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of minimum 24 gauge galvanized sheet steel or 0.032-inch- thick aluminum.
- D. Maximum Installed Length: 14 inch.
- E. Coatings and Adhesives: Comply with UL 181, Class 1.

## 2.7 VOLUME CONTROL DAMPERS

- A. Manufacturers:
  - 1. Air Balance, Inc.
  - 2. Arrow United Industries
  - 3. Cesco
  - 4. Greenheck
  - 5. Louvers & Dampers, Inc.
  - 6. Nailor Industries, Inc.
  - 7. Pottorff
  - 8. Rossi Air Flow
  - 9. Ruskin Mfg. Co.
  - 10. TAMCO
  - 11. Vent Products

- B. Fabricate dampers in accordance with SMACNA (DCS) and as indicated. Construct using galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments.
- C. Single Blade Dampers:
  - 1. Fabricate for duct sizes up to 12 x 36 inch.
  - 2. Blade: 20 gauge, 0.04 inch, minimum.
- D. Multi-Blade Damper: Fabricate of parallel or opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
  - 1. Blade: 18 gauge, 0.0478 inch, minimum.
- E. Bearings: Corrosion resistant, molded synthetic.
- F. Axles: Positively lock into the damper blade.
- G. Blade Seals: Where used for shutoff duty, provide Neoprene seals for round dampers and silicone for rectangular dampers.
- H. Quadrants:
  - 1. Provide locking, indicating quadrant regulators.
  - 2. On insulated ducts, provide extended shafts and mount regulator on standoff bracket, base or adapter.
  - 3. Where rod lengths exceed 48 inches, provide regulator at both ends.

## 2.8 CABLE OPERATED DAMPER SYSTEMS

- A. Manufacturer:
  - 1. DuroDyne, DuroZone.
  - 2. Metropolitan Air Technology, Inc. (Reference model number for round damper is RT-250 and for rectangular damper is RT-200).
  - 3. Young Regulator Co. (Reference model number is 270).
- B. General: Where access to dampers through a hard ceiling is required, provide a concealed, remote cable-operated, butterfly-type volume damper assembly with external worm gear operator.
- C. Damper assembly shall include duct casing with rolled bead stiffeners, reinforced blade, self-lubricating bearing, and remote operator mounting plate.
- D. Adjustable through the diffuser frame with standard 1/4 inch nut-driver or flat screwdriver.
- E. Cable assembly shall attach to damper as a single piece with no linkage adjustment required.
- F. Positive, direct, two-way damper control with no sleeves, springs or screw adjustments to come loose after installation.
- G. Cable length as required to span the distance from the damper to the remote operator location.
- H. Where approved by Architect, a ceiling cup with cover plate can be used for access to cable operator.

## 2.9 FLEXIBLE DUCTWORK

- A. Manufacturers:
  - 1. ATCO Rubber Products.
  - 2. Flexmaster.
  - 3. JPL (J.P. Lamborn Co)
  - 4. Thermaflex.

- B. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regard to required quality of construction and materials.
- C. Insulated Flexible Ductwork: Provide duct fabric of ply-vinyl film, polyethylene film or multiple layers of aluminum laminate supported by helically wound spring steel wire. Wrap fabric with fiberglass insulation and provide fire retardant polyethylene or reinforced metalized protective vapor barrier as specified herein.
  - 1. Duct pressure class up to and including 6" w.g.
    - a. Fire retardant polyethylene vapor barrier
      - 1) ATCO 80 Series
      - 2) Flexmaster Type 5B
      - 3) JPL Type PR Series
      - 4) Thermaflex Type G-KM
    - b. Reinforced metalized vapor barrier
      - 1) ATCO 30 Series
      - 2) Flexmaster Type 5M
      - 3) JPL Type MHP Series
      - 4) Thermaflex Type M-KE
  - 2. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.
  - 3. Provide acoustical, fiberglass insulated duct with minimum R-value of R-6.0.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### **3.2 INSTALLATION OF DUCTWORK ACCESSORIES**

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Provide vanes in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease or dryer exhaust ductwork.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Provide combination fire and smoke dampers, fire dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction.
  - 1. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
  - 2. Coordinate all smoke and fire/smoke damper installation, wiring, and checkout to ensure that the dampers function properly and that they respond to the proper fire alarm system signal.
  - 3. Install ceiling radiation dampers per manufacturer's instructions. Support damper assembly from structure.
  - 4. Demonstrate re-setting of fire and fire/smoke dampers to Owner's representative.
- E. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
  - 1. Provide duct access doors in ductwork at the following locations
    - a. At each change in direction and at maximum 50-foot (15-m) spacing.

- b. Upstream [and downstream] from turning vanes.
2. Provide duct access door(s) as scheduled below, at each fire and smoke damper within 12 inches of the device to allow for testing and maintenance. Label each door (with minimum 1" lettering) indicating which damper type is served. Door shall be capable of being fully opened or provide removable door.

Duct Access Door Schedule		
Duct Width/Depth	Door Size	Quantity
10" to 12"	10 x 10	1
14" to 18"	12 x 12	1
20" to 36"	14 x 14	1
38" to 54"	18 x 18	1
56" to 72"	18 x 18	2 (1 each end)
74" to 96"	20 x 20	2 (1 each end)

3. Provide duct access doors for cleaning kitchen exhaust ducts in accordance with NFPA 96. Review locations prior to fabrication.
- F. Provide flexible duct connections wherever ductwork connects to vibrating equipment and when transitioning between two different metallic duct materials (e.g., aluminum to galvanized steel). Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.
1. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
  2. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- G. Provide volume control dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual volume control damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.
- H. Install flexible ductwork in accordance with manufacturer's instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.
1. Flexible ductwork runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.
  2. Install flexible ductwork straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible ductwork fully extended minimizing compression.
  3. Provide continuous length with no intermediate joints.
  4. Support flexible ductwork from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.
  5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.
  6. Support straps/saddles shall be minimum 1-1/4" wide. Use of wire hanging systems shall utilize strap and connect wire to strap.
    - a. Factory installed suspension systems are acceptable
  7. Do not crimp flexible ductwork against joist or truss members, pipes, conduits, etc.
  8. Install flexible ductwork with bend radius at the center line equal to or greater than one duct diameter.
    - a. Support bends approximately one duct diameter on both sides of bends.
  9. Connect flexible ductwork to sheet metal ductwork and air devices with at least 1" overlap.
- I. Provide rigid duct elbow assembly where a 90 degree elbow is required at connection to air devices.
- J. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

### 3.3 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

- B. After start-up, final corrections and balancing of systems, test duct silencers by taking octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations, as directed. Refer to Division 23 Section "Testing, Adjusting and Balancing of HVAC" for additional requirements.
  - 1. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements.
  - 2. Submit complete report of test results including sound curves.

#### 3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
- B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".
- C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".
- D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

**END OF SECTION 233300**



## **SECTION 233423 - HVAC POWER VENTILATORS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Cabinet exhaust fans.

#### **1.2 SUBMITTALS**

- A. General: Submit data in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements. Include the following:
  - 1. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
  - 2. Materials gages and finishes, including color charts.
  - 3. Dampers, including housings, linkages, and operators.
- C. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
- D. Wiring Diagrams: Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
- E. Maintenance Data: Include instructions for lubrication, motor and drive replacement and spare parts list.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Fan Belts: One set for each individual fan.

#### **1.3 QUALITY ASSURANCE**

- A. AMCA Compliance: Provide products that meet AMCA certified performance and sound ratings and are licensed to use the AMCA Seal.
- B. UL Compliance: Fans and fan motors shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."
- C. Kitchen Hood Exhaust Fans: Kitchen hood exhaust fans and components shall comply with requirements of UL 762 "Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances and NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations".
- D. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.
- E. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- F. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Protect motors, shafts, and bearings from weather and construction dust.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 POWER VENTILATORS - GENERAL**

- A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished; with indicated capacities and characteristics.
- B. Statically and Dynamically Balanced: Fans and shafts shall be statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.
  - 1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.
- C. Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating".
- D. Sound Ratings: Comply with AMCA 301 "Certified Ratings Program Product Rating Manual for Fan Sound Performance". Test fans in accordance with AMCA Standard 300 "Reverberant Room Method for Sound Testing of Fans".
- E. Fabrication: Comply with AMCA 99.
- F. Motors: Refer to Section "Common Motor Requirements for HVAC Equipment" for requirements.
- G. Motor and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
  - 1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.
- H. Hazardous Duty: Provide fans with spark resistant construction and explosion proof motor where specified in the schedule.
- I. Factory Finish: The following finishes are required:
  - 1. Sheet Metal Parts: Prime coating prior to final assembly.
  - 2. Exterior Surfaces: Baked-enamel finish coat after assembly.

### **2.2 CABINET EXHAUST FANS**

- A. Manufacturers:
  - 1. Acme Engrg. & Mfg. Corp.
  - 2. CaptiveAire
  - 3. Carnes Company, Inc.
  - 4. Cook (Loren) Co.
  - 5. Greenheck Fan Corp.
  - 6. PennBarry.
  - 7. Twin City Fan Company
- B. Centrifugal Fan Unit: Centrifugal fan designed for installation in ceiling, wall, or concealed inline applications.
- C. Housing: Galvanized steel lined with acoustical insulation.
- D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Grille: Molded white plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.



- G. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- H. Accessories: Provide the following items as indicated:
  - 1. Remote Fan Speed Control: Solid state, capable of controlling fan speed from full speed to approximately half speed.
  - 2. Manufacturer's standard roof jack, wall cap, and transition fittings for exhaust termination as indicated.

### **PART 3 - EXECUTION**

#### **3.1 SEQUENCING AND SCHEDULING**

- A. Coordinate the size and location of structural steel support members.

#### **3.2 INSTALLATION**

- A. Install fans level and plumb, in accordance with manufacturer's written instructions.
- B. Secure roof-mounted fans to pre-engineered roof equipment supports in accordance with the requirements specified in Section "Hangers and Supports for HVAC Piping and Equipment."
- C. Cabinet Units: Suspend units from structural steel support frame using steel wire or metal straps.
- D. Install vibration isolation for equipment as specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."
- E. Arrange installation to provide access space around fans for service and maintenance.

#### **3.3 ADJUSTING, CLEANING, AND PROTECTING**

- A. Adjust damper linkages for proper damper operation.
- B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

#### **3.4 STARTUP**

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
  - 1. Remove shipping blocking and bracing.
  - 2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
  - 3. Perform cleaning and adjusting specified in this Section.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
  - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
  - 6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
  - 7. Disable automatic temperature control operators.
- B. Starting procedures for fans:
  - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
    - a. Replace fan and motor pulleys as required to achieve design conditions.
  - 2. Measure and record motor electrical values for voltage and amperage.
  - 3. Shut unit down and reconnect automatic temperature control operators.
  - 4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

### 3.5 DEMONSTRATION

- A. Demonstration Services: Train Owner's maintenance personnel on the following:
  - 1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
  - 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."
- B. Schedule training with at least 7 days' advance notice.

**END OF SECTION 233423**

## **SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Ceiling air diffusers.
- B. Registers and grilles.

#### **1.2 REFERENCE STANDARDS**

#### **1.3 SUBMITTALS**

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
  - 1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
  - 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details. Indicate selections on product data.
  - 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, 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. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.
- E. Color Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

#### **1.4 QUALITY ASSURANCE**

- A. Test and rate air outlets and inlets in accordance with ASHRAE 70 Method of Testing the Performance of Air Outlets and Inlets.
- B. Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 Certification, Rating and Test Manual.
- C. Provide air outlets and inlets bearing ADC Certified Rating Seal.
- D. Test and rate sound data for air outlets and inlets in accordance with AHRI 885 Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets (with Addendum 1).
- E. Install air outlets and inlets in accordance with NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems.
- F. Test and rate louvers in accordance with AMCA 500 Test Method for Louvers, Dampers and Shutters.

#### **1.5 SPARE PARTS**

- A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

## **PART 2 - PRODUCTS**

### **2.1 CEILING AIR DIFFUSERS**

- A. Manufacturers
  - 1. Carnes Co.
  - 2. Greenheck.
  - 3. Krueger Mfg. Co.
  - 4. Metalaire; Metal Industries, Inc.
  - 5. Nailor Industries, Inc.
  - 6. Price Industries, Inc.
  - 7. Titus HVAC
  - 8. Tuttle & Bailey; Div. of Air Systems Components, Inc.
- B. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- C. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- D. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
- E. Types: Provide ceiling air diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

### **2.2 REGISTERS AND GRILLES**

- A. Manufacturers
  - 1. Carnes Co.
  - 2. Greenheck.
  - 3. Krueger Mfg. Co.
  - 4. Metalaire; Metal Industries, Inc.
  - 5. Nailor Industries, Inc.
  - 6. Price Industries, Inc.
  - 7. Titus HVAC
  - 8. Tuttle & Bailey; Div. of Air Systems Components, Inc.
- B. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- C. Performance: Provide registers and grilles 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.
- D. Ceiling Compatibility: Provide registers and grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of register and grille.
- E. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.
- F. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.
- C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow.
- D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

#### **3.3 ADJUSTING**

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

#### **3.4 CLEANING**

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

**END OF SECTION 233713**

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## **SECTION 237313 - CENTRAL STATION AIR HANDLING UNITS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Casing construction.
- B. Fan section.
- C. Coil section.
- D. Filter and air cleaner section.
- E. Access section.

#### **1.2 DEFINITIONS**

- A. Low Pressure: Greater than 1 inch w.c. and less than or equal to 4 inches w.c. internal positive or negative pressure.
- B. Medium Pressure: Greater than 4 inches w.c. and less than 10 inches w.c. internal positive or negative pressure.
- C. High Pressure: Greater than or equal to 10 inches w.c. internal positive or negative pressure.

#### **1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination: Coordinate the installation with size, location and installation of service utilities.
- B. Coordinate the work with other trades for installation of roof mounted air handling units on roof curbs.
- C. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- D. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

#### **1.4 SUBMITTALS**

- A. Product Data:
  - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
  - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
  - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
  - 4. Sound Power Level Data: Certified fan outlet, inlet, and casing radiation at rated capacity. For variable speed fans, provide sound ratings at 100, 80 and 60 percent of maximum rpm.
  - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
  - 6. Certified coil performance ratings with system operating conditions indicated.
  - 7. Motor ratings and electrical characteristics plus motor and fan accessories.
  - 8. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.
  - 9. Dampers, including housings, linkages, and operators.
  - 10. Total pressure drop for the unit with itemized pressure drop per module. At a minimum, provide line items for the following:
    - a. External static pressure loss.
    - b. Unit inlet and outlet opening losses.
    - c. Internal filter, coil, and casing losses.
    - d. Pressure drop per module.
- B. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

- C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- D. Specimen Warranty: Submit sample of manufacturer's warranty.
- E. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- F. Manufacturer's Instructions: Include installation instructions.
- G. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Fan Belts: One set for each unit.
  - 2. Extra Filters: One set for each unit.
- I. Product certificates signed by manufacturers of central-station air-handling units certifying that their products comply with specified requirements.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. AHRI Certification: Comply with the following for the applicable components,
  - 1. Factory test central-station air-handling units and their components in accordance with the applicable portions of AHRI 430 "Performance Rating of Central-Station Air-Handling Units". Units shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute.
  - 2. AHRI 260 "Sound Rating of Ducted Air Moving and Conditioning Equipment".
  - 3. AHRI 410 "Standard for Forced-Circulation Air-Cooling and Air-Heating Coils".
  - 4. AHRI 640 (I-P) "Performance Rating Of Commercial and Industrial Humidifiers".
  - 5. AHRI 1060 I-P "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment".
- C. AMCA Compliance: Comply with the following standards for rating and testing of the applicable components specified herein.
  - 1. AMCA 210 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating".
  - 2. AMCA 300 "Reverberant Room Method for Sound Testing of Fans".
  - 3. AMCA 301 "Methods for Calculating Fan Sound Ratings from Laboratory Test Data".
  - 4. AMCA 500-D "Laboratory Methods of Testing Dampers for Rating".
  - 5. AMCA 500-L "Laboratory Methods of Testing Louvers for Rating".
  - 6. AMCA 611 "Certified Ratings Program for Airflow Measurement Stations".
- D. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."
- E. UL Compliance: Electric coils, along with the complete central-station air-handling unit, shall be listed and labeled by Underwriters' Laboratories. Comply with the following for the applicable components.
  - 1. UL 508 "Industrial Control Equipment".
  - 2. UL 795 "Commercial-Industrial Gas Heating Equipment".
  - 3. UL 1598 "Luminaires".
  - 4. UL 1812 "Ducted Heat Recovery Ventilators".
  - 5. UL 1995 "Heating and Cooling Equipment".
- F. Nationally Recognized Tested Laboratory and NEMA Compliance (NRTL): Electric coils, along with the complete central-station air-handling unit shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

#### 1.6 DELIVERY, STORAGE, AND HANDLING



- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Follow manufacturer's written instructions for rigging. Inspect for damage. Replace damaged units or components.
- B. Store in clean dry place off the ground and protect from weather, physical damage, and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. Replace any sections that experience internal water damage due to lack of protection.
- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- D. Ship in required shipping splits as described on contract documents.

#### 1.7 SPARE PARTS

- A. General: Furnish to Owner, with receipt, the following spare parts for each air-handling unit.
  - 1. Furnish one additional complete set of belts for each central-station air-handling unit.
  - 2. Furnish one additional gasket for each sectional joint of each central-station air-handling unit.

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 MANUFACTURERS

- A. Daikin Applied.
- B. Trane.

#### 2.2 MANUFACTURED UNITS

- A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, plenums, filters, and drip pans.
- B. Types: Central-station air-handling units included in this project are of the following types:
  - 1. Draw-through.
- C. Motor: Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.
- D. Electrical Components: Refer to Division 26 Sections.

#### 2.3 CASING CONSTRUCTION

- A. Full Perimeter Base Rail:
  - 1. Construct of galvanized steel.
  - 2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.
- B. Casing:
  - 1. Construct of one piece, insulated, double wall panels.
  - 2. Provide mid-span, no through metal, internal thermal break.
  - 3. Construct outer panels of galvanized steel and inner panels of galvanized steel.
  - 4. Casing Air Pressure Performance Requirements:
    - a. Able to withstand up to 4 inches w.g. positive or negative static pressure.
  - 5. Medium and high-pressure units shall be constructed with additional bracing and supports. Units rated at 5.5 inches w.g. and higher shall be connected to accessories sections with double-thickness neoprene-coated flexible connection.
- C. Access Doors:
  - 1. Construction, thermal and air pressure performance same as casing.

2. Provide surface mounted handles on hinged, swing doors.
- D. Unit Flooring: Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities.
- E. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.
- F. Insulation:
1. Insulation: Comply with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems," for insulation.
    - a. Type:
      - 1) Coated, glass-fiber insulation having a minimum density of 1-1/2 pcf.
      - 2) Foam injection.
    - b. Thickness: 1 inch.
    - c. Minimum R-Value: R-4.
    - d. Completely fill panel cavities in each direction to prevent voids and settling.
    - e. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.
- G. Drain Pan Construction:
1. Double-Wall Drain Pans: Formed sections of galvanized sheet steel. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at the maximum cataloged face velocity across the cooling coil. Fill space between double-wall construction with foam insulation and seal moisture tight. Comply with ASHRAE Std 62.1 for indoor air quality and sufficiently size to collect all condensate.
  2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
  3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
  4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.
  5. Drain connections: Both ends of the pan.
  6. Pan top surface coating: Elastomeric compound.
  7. Units with stacked coils shall have an intermediate drain pan or a drain trough to collect condensate from top coil.
- H. Finish:
1. Indoor Units:
    - a. Provide exterior, galvanized steel panels without paint.

## 2.4 FAN SECTION

- A. Type: Centrifugal type fans shall be double-width, double-inlet type with forward-curved blades or backward-curved airfoil section blades as best suited for the application. Plenum type fans shall have backward-inclined airfoil blades with heavy gauge spun aluminum inlet cone.
- B. Performance Ratings: Unit's fans performance ratings for flow rate, pressure, power, air density, speed of rotation, and efficiency shall be factory tested and ratings established in accordance with AMCA 210/ASHRAE Standard 51 and labeled with AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- D. Bearings: Heavy duty pillow block type, ball bearings, with ABMA STD 9, L-10 life at 200,000 hours. Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.
- E. Mounting:
1. Fan section shall be equipped with a formed steel channel base for integral mounting of fan, motor, and casing panels. The fan scroll, wheel, shaft, bearings, and motor shall be mounted on a structural steel frame with frame mounted on base.
  2. Factory mount motor on slide rails.
  3. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.
  4. Provide built-in inertia base of welded steel with bottom sheet and reinforcing grid for concrete ballast.

5. Mount base on vibration isolators.
- F. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.
- G. Motor Wiring Conduit: Factory wire fan motor wiring to the unit mounted starter-disconnect, variable frequency drive, and external motor junction box.
- H. Drives:
  1. Conform to AMCA 99.
  2. Factory mounted with final alignment and belt adjustment made after installation.
  3. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil. Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.
  4. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
  5. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

## 2.5 COIL SECTION

- A. Testing Requirements: The following factory tests are required:
  1. Coil Performance Tests: Cooling and heating coils, except sprayed surface coils, shall be factory tested for rating in accordance with AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. Coil Pressure Ratings:
  1. Water Coils: Design for 200 psi working pressure at 325 F, and pressure test at 300 psi under water.
- C. Coil Sections: Common or individually insulated, galvanized steel casings for heating and cooling coils. Coil section shall be designed and constructed to facilitate removal of coil for maintenance and replacement and to assure full air flow through coils.
  1. Multizone units shall have air deflectors and air baffles for balanced air flow across both heating and cooling coils.
  2. Medium and high-pressure units shall have double gaskets between sections and coil connection penetrations through casing sealed to minimize leakage.
- D. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- E. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- F. Eliminators: Three break of galvanized steel, mounted over drain pan.
- G. Air Coils:
  1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
- H. Fabrication:
  1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
  2. Fins: Aluminum or copper, constructed from flat plate with belled collars for tubes. Fins shall be bonded to tubes by mechanically expanding copper tubes.
    - a. Thickness: Minimum 0.006 inches.
    - b. Spacing: Maximum 12 fins per inch.
  3. Casing: Die formed channel frame of galvanized steel.
  4. Water Coil Turbulators: Bronze, spring-type.
- I. Water Heating Coils:
  1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
  2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type.

- J. Water Cooling Coils:
  - 1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
  - 2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

## 2.6 FILTER AND AIR CLEANER SECTION

- A. General:
  - 1. Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.
  - 2. Filters shall comply with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."
  - 3. Filter Section: Cabinet material and finish shall match the air-handling unit cabinet, with filter media holding frames arranged for flat or angular orientation. Section shall have access doors on both sides of the unit.
- B. Differential Pressure Gage:
  - 1. Provide factory installed dial type differential pressure gage, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
  - 2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.

## 2.7 ACCESS SECTION

- A. Provide where indicated on the Drawings to allow for inspection, cleaning, and maintenance of field installed components.
- B. Construct access doors same as previously specified within this Section.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Support floor-mounted units on concrete equipment bases using housed spring isolators. Secure units to anchor bolts installed in concrete equipment base.
- C. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.
- D. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- E. Bolt sections together with gaskets.
- F. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as indicated. Refer to Section "Vibration Isolation for HVAC". Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- G. Provide fixed sheaves required for final air balance.
- H. Make connections to coils with unions or flanges.
- I. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:
  - 1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.

2. Route unit condensate drain piping to location shown on the plan or, if not shown, to the nearest equipment or floor drain. Provide trap at connection to drain pan with depth as noted on the drawings and install cleanouts at changes in direction. Size condensate drain piping in accordance with local code and as shown on the drawings.
- J. Duct installations and connections are specified in other Division 23 sections. Make final duct connections with flexible connections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- K. Electrical Connections: The following requirements apply:
1. Electrical power wiring is specified in Division 26.
  2. Temperature control wiring and interlock wiring is specified in Division 23 section "Direct-Digital Control for HVAC."
- L. Grounding: Connect unit components to ground in accordance with the National Electrical Code.
- M. Hydronic Coils:
1. Connect water supply to leaving air side of coil (counterflow arrangement).
  2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
  3. Locate water supply at bottom of supply header and return water connection at top.
  4. Provide manual air vents at high points complete with stop valve.
  5. Ensure water coils are drainable and provide drain connection at low points.
- N. Insulate Coil Headers Located Outside Air Flow as Specified for Piping: Refer to Section "HVAC Insulation" for additional requirements.
- O. Field-wire each factory provided control for field installation.

### 3.3 EQUIPMENT BASES

- A. Construct concrete equipment pads in accordance with Section "Common Work Results for HVAC."

### 3.4 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.
- B. Adjust damper linkages for proper damper operation.
- C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

### 3.5 FIELD QUALITY CONTROL

- A. Vibration Analysis:
1. Measure vibration levels with an FFT (Fast Fourier Transformation) analyzer.
  2. Characteristics:
    - a. Frequency Response Range: 5 Hz thru 10 KHz (300 thru 600,000 cpm).
    - b. Capability to use a Hanning window.
    - c. Capacity to perform ensemble averaging.
    - d. Auto-ranging frequency amplitude.
    - e. Minimum amplitude accuracy over the selected frequency range of plus/minus 20 percent or plus/minus 1.5 dB.
  3. Use accelerometer, stud-mounted to collect data.
  4. Ensure the mass of the accelerometer and its mounting have minimal influence on the frequency response of the system over the selected measurement range.
- B. Final Acceptance Requirements:
1. Use dial indicator gages to demonstrate fan and motor are aligned.
  2. Verify conformance to specifications using vibration analysis.
  3. Maximum Vibration Levels:
    - a. 0.075 inch per second at 1 times run speed and at fan/blade frequency.

- b. 0.04 inch per second at other multiples of run speed.

### 3.6 SYSTEM STARTUP

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
  - 1. Remove shipping, blocking, and bracing.
  - 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
  - 3. Perform cleaning and adjusting specified in this Section.
  - 4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
  - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
  - 6. Set zone dampers to full open for each zone.
  - 7. Set face-and-bypass dampers to full face flow.
  - 8. Set outside-air and return-air mixing dampers to minimum outside-air setting.
  - 9. Comb coil fins for parallel orientation.
  - 10. Install clean filters. Do not operate air handling unit without pre-filters installed.
  - 11. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
  - 12. Disable automatic temperature control operators.
- B. Provide manufacturer's field representative to observe and approve systems startup.
- C. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.
- D. Adjust for proper operation within manufacturer's published tolerances.
- E. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
  - 1. Replace fan and motor pulleys as required to achieve design conditions.
  - 2. Measure and record motor electrical values for voltage and amperage.
  - 3. Shut unit down and reconnect automatic temperature control operators.
  - 4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

### 3.7 TRAINING

- A. At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel on the operation and maintenance of the equipment provided under this section.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
  - 1. Use operation and maintenance data as reference during demonstration.
  - 2. Conduct walking tour of project.
  - 3. Briefly describe function, operation, and maintenance of each component.
- C. Training: Train Owner's personnel on operation and maintenance of system.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  - 2. Provide minimum of four hours of training.
  - 3. Instructor: Manufacturer's training personnel.
  - 4. Location: Owner's offsite classroom facilities may be used.
- D. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.
- E. Schedule: Schedule training with Owner with at least 7 days' advance notice.

### END OF SECTION 237313

## **SECTION 237433 - DEDICATED OUTDOOR AIR UNITS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Package rooftop mounted units capable of supplying 100 percent outdoor air.

#### **1.2 SUBMITTALS**

- A. Product Data: Provide manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, and furnished specialties and accessories. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.
- B. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- C. Shop Drawings:
  - 1. Submit manufacturer's assembly-type shop drawings indicating dimensions, required clearances, and methods of assembly of components
  - 2. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.
- D. Wiring Diagrams: Submit wiring diagrams detailing the manufacturer's electrical requirements for power supply wiring for dedicated outdoor air heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- E. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- F. Operation and Maintenance Data: Submit maintenance data and parts list for each dedicated outdoor air unit, including "trouble-shooting" maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in maintenance manual; in accordance with requirements of Division 1.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

#### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Codes and Standards:
  - 1. Gas-fired furnace section construction shall be in accordance with AGA safety standards. Furnace section shall bear the AGA label.
  - 2. AHRI Compliance:
    - a. Testing and rating of dedicated outdoor air units capacity shall be in accordance with AHRI 920 "Performance Rating of DX Dedicated Outdoor Air System Units".
    - b. Capacity ratings for air-to-air energy recovery equipment shall comply with AHRI 1060 "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment".
    - c. Capacity ratings for water coils shall comply with AHRI 410 "Forced-Circulation Air- Cooling and Air-Heating Coils".
    - d. Sound testing and rating of units shall be in accordance with AHRI 270 "Sound Performance Rating of Outdoor Unitary Equipment". Units shall bear Certified Rating Seal.
  - 3. Refrigerating system construction of dedicated outdoor air units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

4. Integrated Seasonal Moisture Removal Efficiency (ISMRE) and Integrated Seasonal Coefficient of Performance (ISCOP) of dedicated outdoor air units shall be equal to or greater than prescribed by ASHRAE 90.1 "Energy Standard For Buildings Except Low-Rise Residential Buildings".
5. Dedicated outdoor air units shall be listed by UL and have UL label as a unit. Comply with UL 1995 "Heating and Cooling Equipment".
6. Dedicated outdoor air units shall be designed, manufactured, and tested in accordance with UL requirements.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Accept products, with factory-installed shipping skids and lifting lugs. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units. Inspect for damage.
- B. Protect units from physical damage by storing off site or in locked, protected area until roof mounting curbs are in place, ready for immediate installation of units.

#### 1.5 SPECIAL WARRANTY

- A. Warranty on Compressor and Gas Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and gas heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.
  1. Warranty Period: 5 years from date of substantial completion.

#### 1.6 SPARE PARTS

- A. General: Furnish to Owner, with receipt, the following spare parts for each dedicated outdoor air unit.
  1. One set of matched fan belts for each belt driven fan.
  2. One set of spare filters of each type required for each unit. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of installation work, and prior to testing, adjusting, and balancing work.
  3. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 PACKAGED ROOFTOP UNITS

- A. Manufacturers
  1. Trane.
  2. Lennox.
  3. Daikin.
- B. Manufactured Units
  1. General: Roof or slab mounted units, factory assembled, prewired and tested,
  2. Description: Self-contained, packaged unit consisting of compressors, condensers, evaporator coils, heating system, condenser and evaporator fans, energy recovery device, refrigeration and temperature controls, filters, and dampers. Capacities and electrical characteristics shall be as scheduled on the Drawings.
  3. Refrigerant: Provide dedicated outdoor air units designed to operate with refrigerant as scheduled on the drawings.
- C. Fabrication
  1. Cabinet: Provide manufacturer's standard double wall casing construction with fiberglass or foam-injected insulation that provides a minimum R-6 R value. Incorporate a thermal break such that there is no through metal path between the interior and exterior surface of the unit casing at all panel frames, joining mullions, or corners. Provide corrosion protection coating and exterior finish that meets ASTM B117 salt spray test of



- minimum 500 hours. Provide removable panels or access doors for inspection and access to internal parts, knockouts for electrical and piping connections, an exterior condensate drain connection and lifting lugs.
      - a. Bottom Duct Connections: Provide steel or aluminum walking grate on structural supports where connections are located in sections accessible by personnel for maintenance.
    - 2. Condensate Drain Pan: Provide galvanized or stainless steel condensate drain pan sloped to drain connection.
    - 3. Filters Section: Provide filter housing of material matching the unit casing with gasketed filter media holding frames. Size housing to accommodate the filters scheduled on the drawings. Provide access panel(s) large enough for filter replacement with continuous gasketing and positive locking devices.
    - 4. Roof Curbs: Refer to Section "Hangers and Supports for HVAC" for pre-engineered roof equipment supports and Section "Vibration Isolation for HVAC Piping and Equipment" for vibration isolated equipment support bases.
  - D. Fans
    - 1. Supply Fans:
      - a. Provide forward-curved or backward inclined, centrifugal fan wheel, V-belt drive with adjustable variable pitch motor pulley or direct drive, rubber isolated hinge mounted high efficiency motor and permanently lubricated motor bearings.
      - b. Provide plenum fan with airfoil blade wheel with heavy gauge spun aluminum inlet cone.
    - 2. Exhaust Fan: Provide a forward curved exhaust fan(s) with adjustable V-belt drive and a backdraft damper.
    - 3. Condenser Fans: Provide propeller-type, direct-driven fans, resiliently mounted with fan guard, with permanently lubricated bearings.
  - E. Motors:
    - 1. Refer to Section "Common Motor Requirements for HVAC Equipment" for requirements.
  - F. Air Filtration
    - 1. Pre-Filters Section: Provide fiberglass throwaway pleated filters in filter rack, with maximum face velocity of 400 fpm. Provide filters of thickness and minimum MERV rating per ASHRAE 52.2as scheduled on the drawings.
  - G. Gas-Fired Heat Exchangers:
    - 1. Provide aluminized steel construction for gas-fired heat exchangers and burners with entering air temperatures higher than 50 F. Provide stainless steel construction for gas-fired heat exchangers and burners with entering air temperatures less than or equal to 50 F or have airstreams that are corrosive. Provide heat exchangers and burners designed for staged or modulating operation as scheduled or noted on the drawings with minimum efficiency of 80 percent. Provide single gas connection.
    - 2. Gas Burner: Atmospheric or power-vented type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot.
    - 3. Operating Controls: Provide the following controls for the gas-fired heat exchangers:
      - a. Intermittent pilot ignition;
      - b. Electronic spark ignition system;
      - c. High limit cutout;
      - d. Forced draft proving switch;
      - e. Flame roll-out switch.
  - H. Evaporator DX Coils
    - 1. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
    - 2. Provide equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant.
    - 3. Provide interlaced coils in multiple stage units to ensure full coverage over coil face.
    - 4. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of refrigerant.
    - 5. Provide 1 inch factory installed flexible elastomeric insulation around the suction and liquid lines not directly located above a condensate drain pan. If any piping is exposed to sunlight, provide UV protective coating.
  - I. Hot Gas DX Reheat Coils:
    - 1. Provide hot gas reheat coil with staged or modulating control for reheat during dehumidification operation. Size hot gas reheat coil capacity to maintain supply air temperature when unit is operating in the dehumidification mode. Refer to control drawings.
  - J. Compressors

1. Provide serviceable, semi-hermetic, or fully hermetic compressors, complete with integral vibration isolators and crankcase heaters which de-energize during compressor operation.
  2. Units shall have the following capacity control measures to prevent excessive compressor short cycling and prevent evaporator coil from freezing:
    - a. Digital scroll compressor as the first stage.
    - b. Inverter scroll compressor as the first stage.
  3. Heat Pump Units: Provide reversing valve with a replaceable magnetic coil, suction line accumulator, flow control check valve, and solid state defrost control utilizing thermistors. Refrigerant system shall have a pump-down cycle.
  4. Accessories: Thermal expansion valves, filter dryers, sight glasses, compressor service valves, liquid line service valves; minimum of 2 refrigerant circuits for units having 2 or more compressors.
- K. Condenser Coils
1. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.
  2. Provide corrosion protective coating where scheduled.
  3. Provide refrigerant pressure switches to cycle condenser fans,
- L. Air Connections
1. Dampers: Dampers and their operators shall comply with performance requirements specified in Division 23 Section "Instrumentation and Control Devices for HVAC."
  2. Supply Air: Provide flanged connection with gasket to minimize air leakage.
  3. Outdoor Air: Provide intake hood or louver designed to inhibit wind-driven rain and snow from entering unit.
    - a. Provide complete with birdscreen, 1/2" mesh aluminum or stainless steel.
    - b. Dampers: Provide outside air damper constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven.
- M. Energy Recovery Devices.
1. Energy Recovery Wheel: Provide a factory mounted, wired, and tested energy recovery wheel. The energy recovery wheel shall have latent and sensible recovery capacities as required to meet or exceed the capacities scheduled on the drawings.
    - a. Mount the energy recovery wheel in a rigid frame containing the wheel drive motor, redundant drive belts, wheel seals, and bearings.
    - b. Provide an energy recovery wheel constructed of a light weight polymer material with permanently bonded desiccant coating. The wheel shall be removable from the cabinet and cleanable using hot water or light detergent without degrading the latent efficiency.
    - c. Provide a filter bank on the upstream side of each air stream with 2" thick fiberglass throwaway filters in filter rack, with maximum face velocity of 400 fpm and minimum MERV rating per ASHRAE 52.2 of MERV 8.
    - d. Bypass Dampers: Provide bypass dampers for economizer control. The energy recovery wheel shall be sized for the full airflow as scheduled.
- N. Operating Controls:
1. Provide solid-state control board and components that contain at a minimum the following features:
    - a. Supply fan on/off delay.
    - b. Default control to ensure proper operation after power interruption.
    - c. Service relay output.
    - d. Unit diagnostics and diagnostic code storage.
    - e. Field-adjustable control parameters.
    - f. Minimum run time.
    - g. Fan-proving switch to lock out unit if fan fails.
  2. DDC Interface: Install stand-alone control module providing link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Division 23 section "Direct Digital Control for HVAC."
- O. Safety Controls: Provide manual reset type safety controls for:
1. Low pressure cutout;
  2. High pressure cutout;
  3. Compressor motor overload protection.
  4. Anti-recycling timing device;
  5. Adjustable low-ambient lockout;
  6. Oil pressure switch.

- P. Electrical:
1. Provide a 125 VAC, 20 amp duplex convenience receptacle mounted to unit ready for field wiring through the curb with a cover UL listed for wet and damp locations when in use.
  2. Unit power connection shall be either through unit cabinet or within roof curb perimeter.
  3. Dedicated outdoor air units shall be designed to meet a minimum short-circuit withstand rating as specified on the drawings.
- Q. Accessories: Units shall include the following accessories where scheduled or shown on the drawings:
1. Anti-recycling control to automatically prevent compressor restart for 5-minutes after shutdown.
  2. Provide guards to protect the condenser coil from hail or other damage.
  3. Provide smoke detector factory installed in supply air.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas and conditions under which dedicated outdoor air units are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of units.
- B. Examine roughing-in for dedicated outdoor air units to verify actual locations of piping and duct connections before equipment installation.
- C. For roof installed units, verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.
- D. Do not proceed with work until unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION OF DEDICATED OUTDOOR AIR UNITS**

- A. General: Install dedicated outdoor air units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Secure roof-mounted units to roof equipment supports and grade-mounted units to curbs or base. Refer to the drawings for the type of support required for each dedicated outdoor air unit.
1. Refer to Section "Hangers and Supports for HVAC Piping and Equipment" for standard roof curbs.
  2. Refer to Section "Vibration Isolation For HVAC" for vibration isolation curbs.
- C. Support suspended units from structural steel support frame using threaded steel rods and spring hangers. Comply with Division 23 section "Vibration Isolation For HVAC Piping and Equipment".
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.
1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- E. Ductwork: Refer to Division-23 section "Metal Ducts". Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.
- F. Piping: Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties.
- G. Connect condensate drain piping to the unit with appropriate trap. Verify that the piping material and installation is in accordance with Division 22 requirements.
- H. Connect gas piping to gas-fired heat exchanger according to requirements of Division 22 section "Natural Gas Systems." Provide union with sufficient clearance for burner removal and service

### 3.3 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust fan for required airflow in accordance with Section "Testing, Adjusting and Balancing for HVAC." Tighten belts as required for proper operation.
- B. Adjust damper linkages for proper damper operation.
- C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

### 3.4 STARTUP

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
  - 1. Remove shipping, blocking, and bracing.
  - 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
  - 3. Perform cleaning and adjusting specified in this Section.
  - 4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
  - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
  - 6. Comb coil fins for parallel orientation.
  - 7. Install clean filters. Do not operate air handling unit without pre-filters installed.
  - 8. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
  - 9. Disable automatic temperature control operators.
- B. Start-Up Services: Provide the services of a factory-authorized service representative to start-up dedicated outdoor air units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
  - 1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
    - a. Replace fan and motor pulleys as required to achieve design conditions.
    - b. Measure and record motor electrical values for voltage and amperage.
    - c. Shut unit down and reconnect automatic temperature control operators.
    - d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for system testing, adjusting, and balancing.

### 3.5 TRAINING

- A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.
- B. Content: Training shall include but not be limited to:
  - 1. Overview of the system and/or equipment as it relates to the facility as a whole.
  - 2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
  - 3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."
- C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.
- D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

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## **SECTION 238200 - TERMINAL HEATING AND COOLING UNITS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Cabinet heaters
- B. Fan-Coil units

#### **1.2 SUBMITTALS**

- A. Product Data: Submit product data for terminal heating and cooling units showing capacities, ratings, performance characteristics, and gages and finishes of materials..
- B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.
  - 1. Indicate length and number of pieces of elements and enclosures.
  - 2. Show corner pieces, end caps, cap strips, access doors and pilaster covers.
  - 3. Show support points and fastening methods.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to terminal heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- E. Operation and Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

#### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. AHRI Compliance: Comply with the following AHRI standards for the applicable components specified herein.
  - 1. AHRI 210/240 "Performance Rating of Unitary Air-conditioning & Air-Source Heat Pump Equipment".
  - 2. AHRI 350 "Sound Performance Rating of Non-Ducted Indoor Air Conditioning Equipment".
  - 3. AHRI 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".
  - 4. AHRI 440 "Performance Rating of Room Fan-Coil".
  - 5. AHRI 840 "Performance Rating of Unit Ventilators".
- C. I=B=R Compliance: Test and rate baseboard and finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.
- D. ISO Compliance: Fan coil units shall be manufactured in accordance with standard ISO 9001, Quality Management Systems, most current edition.
- E. NFPA Compliance:
  - 1. NFPA 70 "National Electric Code".
  - 2. NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems".
- F. UL compliance:

1. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
2. UL 674 "Electrical Motors and Generators for Use in Hazardous (Classified) Locations".
3. UL 723 "Standard for Test for Surface Burning Characteristics of Building Materials, Underwriter's Laboratory".
4. UL 1995 "Heating and Cooling Equipment.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle terminal heating and cooling units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal heating and cooling units or components; replace with new.
- B. Store terminal heating and cooling units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading terminal heating and cooling units, and moving them to final location.

#### 1.5 SPARE PARTS

- A. General: Furnish to Owner, with receipt, the following spare parts for terminal heating and cooling units.
  1. One set of matched fan belts for each belt driven fan.

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 CABINET HEATERS

- A. Manufacturers:
  1. Daikin Applied.
  2. Modine Mfg. Co.
  3. Trane (The) Co.
- B. General: Provide cabinet heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, and insulation.
- C. Chassis: Galvanized steel wrap-around structural frame with edges flanged.
- D. Insulation: Faced, heavy density glass fiber.
- E. Cabinet: 16-ga removable front panel, 18-ga top and side panels. Insulate front panel over entire coil section. Provide access door on coil connection side. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.
- F. Water Coils: Construct of 5/8" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 200 psi and pressure test at 300 psi under water. Provide same end connections for supply and return.
- G. Fans: Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded, fiberglass- reinforced thermo-plastic material. Construct fan scrolls of galvanized steel.
- H. Motors: Provide shaded pole motors with integral thermal over-load protection, and motor cords for plug-in to junction box in unit.
- I. Filters: Provide minimum 1" thick throwaway type filters with minimum MERV rating per ASHRAE 52.2 of MERV 4.
- J. Accessories: Provide the following accessories as indicated and/ or scheduled.



1. Wall Boxes: Provide aluminum wall boxes with integral eliminators and insect screen.
2. Recessing Flanges: Provide 18-ga steel flanges for recessing cabinet heaters into wall or ceiling.
3. Sub-bases: Provide 18-ga steel sub-base for vertical units, height as indicated.
4. Extended Oilers: Provide plastic motor oiler tubes extending to beneath top discharge grille.

## 2.2 FAN-COIL UNITS

- A. Manufacturers:
  1. Trane.
  2. Daikin Applied.
- B. General: Provide fan-coil units having cabinet sizes, and in locations indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coils, fanboard, drain pan assembly, fans, housing, motor, filter and insulation.
  1. Units shall be listed according to UL 1995.
  2. Units shall be certified according to AHRI 440.
  3. Units shall be manufactured in accordance with ISO 9001.
- C. Chassis: Construct chassis of galvanized steel with flanged edges.
- D. Insulation: Provide minimum 1/2-inch thick insulation for sound and thermal protection.
  1. Provide faced, heavy density glass fiber.
- E. Cabinet: Construct of 18-ga steel removable panels, 16-ga front. Provide insulation over entire coil section. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.
- F. Water Coils: Construct of 1/2 inch or 5/8 inch seamless copper tubes mechanically bonded to configured aluminum fins. Provide manual air vent to allow coil venting. Design for minimum 200 psi working pressure, and factory pressure test at minimum 300 psi under water.
- G. Drain Pans: Construct of galvanized steel. Insulate with polystyrene, elastomeric closed cell foam, or polyurethane insulation. Provide drain connection.
- H. Fans: Provide centrifugal forward curved double width wheels of reinforced fiberglass or galvanized steel, in galvanized steel fan scrolls.
- I. Motors: Provide motors with integral thermal overload protection. Run test motors at factory in assembled unit prior to shipping. Provide quickly detachable motor cords.
- J. Filters: Provide throwaway pleated type filters in fiberboard frames. Filters shall have minimum MERV rating per ASHRAE 52.2 of MERV 8 or as scheduled on the drawings.
- K. Electrical: Unit shall have single point power connection with voltage and phase as scheduled on the drawings.
- L. Accessories: Provide the following accessories as indicated and/or scheduled:
  1. Provide a service disconnect switch to isolate power from the unit during maintenance.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine areas to receive terminal heating and cooling units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install terminal heating and cooling units in accordance with manufacturer's written instructions.
- B. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation. Refer to Section "Vibration Isolation for HVAC" for additional requirements.
- C. Arrange installation of units to provide access space around units for service and maintenance.
- D. Cabinet Heaters
  - 1. Locate cabinet heaters as indicated, coordinate with other trades to ensure correct recess size for recessed units.
- E. Fan Coil Units
  - 1. Install fan coil units level and plumb.
  - 2. Install fan coil units to comply with NFPA 90A.
  - 3. Ductwork: Refer to Division-23 section "Metal Ducts". Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

### 3.3 PIPING CONNECTIONS

- A. Piping: Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:
  - 1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
  - 2. Connect water supply piping to the air leaving side of water coils.
  - 3. Connect condensate drain piping to the unit with appropriate trap. Verify that the piping material and installation is in accordance with Division 22 requirements.

### 3.4 ELECTRICAL WIRING

- A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

### 3.5 ADJUSTING AND CLEANING

- A. General: Just prior to substantial completion clean unit's exposed surfaces and vacuum clean internal components including fan wheel, fan cabinet, all heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.
- B. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.
- C. Install new filters in terminal heating and cooling units requiring same. Do not operate units without filters installed.

### 3.6 STARTUP

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
  - 1. Remove shipping, blocking, and bracing.
  - 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
  - 3. Perform cleaning and adjusting specified in this Section.
  - 4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
- B. Start-Up Services: Start-up terminal heating and cooling units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
  1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
    - a. Replace fan and motor pulleys as required to achieve design conditions.
    - b. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for system testing, adjusting, and balancing.

### 3.7 TRAINING

- A. At a time mutually agreed upon between the Owner and Contractor, engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain terminal heating and cooling units.
- B. Content: Training shall include but not be limited to:
  1. Overview of the system and/or equipment as it relates to the facility as a whole.
  2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
- C. Review data included in the operation and maintenance manuals.

**END OF SECTION 238200**



## **SECTION 260010 - GENERAL ELECTRICAL REQUIREMENTS**

### **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 and to all following sections within Division 26.

#### **1.2 SECTION INCLUDES**

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, 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, supplies, tools, equipment, transportation and utilities.
- B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

#### **1.3 DEFINITIONS**

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
  - 1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
  - 2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
  - 3. Provide: "To furnish and install complete, and ready for the intended use."
  - 4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division."
  - 5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division.
    - a. A Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
  - 6. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is the "Architect".
  - 7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
  - 8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.

9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
    - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
    - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
  10. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
  11. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified
- B. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
- C. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- D. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.
  1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
  3. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference, unless otherwise noted.
- E. The following definitions apply to excavation operations:
  1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
  2. Sub-base: as used in this section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.
  3. Sub-grade: as used in this section refers to the compacted soil immediately below the slab or pavement system.
  4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

#### 1.4 REFERENCE STANDARDS

- A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

- D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

IBC	International Building Code
ADA	Americans with Disabilities Act
AEIC	Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
ICEA	Insulated Conductors Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code, NFPA 70
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers' Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
UL	Underwriter's Laboratories

- E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.
- G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

#### 1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.
- C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.
- D. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- E. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes installed.
- F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
- G. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this

Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

#### 1.6 MEASUREMENTS AND LAYOUTS:

- A. The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

#### 1.7 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.
  - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
  - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
  - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
  - 4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
  - 5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
  - 6. Indicate required installation sequence to minimize conflicts between entities.
  - 7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
  - 8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
  - 1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
  - 2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
  - 3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
  - 4. Include work provided by others routed through the equipment rooms.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
  - 1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
  - 2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
    - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
  - 3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
  - 4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.



## 1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time or time specified in the Engineer's Agreement with the Client, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. Submittals shall contain the following information:
  - 1. The project name.
  - 2. The applicable specification section and paragraph.
  - 3. Equipment identification acronym as used on the drawings.
  - 4. The submittal date.
  - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
  - 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.
- M. Video Recordings: Record all equipment training and demonstrations in .AVI format, unless noted otherwise in Division 01 specifications or where approved by the Owner.

## 1.9 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
  - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
  - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
  - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the [Engineer, Contract Administrator, and Owner the following:
    - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    - c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
    - d. Same warranty will be furnished for proposed substitution as for specified Work.
    - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
  - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
  - 2. Prior to receipt of Bids: No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
    - a. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
  - 3. After receipt of Bids: No substitutions will be considered after receipt of Bids and before award of the Contract.
  - 4. After award of Contract: No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

## 1.10 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.
- C. Contact the Contract Administrator for written authorization.
- D. The following must be received before electronic drawing files will be sent:
  - 1. Contract Administrator's written authorization
  - 2. Engineer's release agreement form
  - 3. Payment

## 1.11 QUALITY ASSURANCE

- A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.

- B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

#### 1.12 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish the Operation and Maintenance Manuals to the Contract Administrator, for Engineer's review, and for the Owner's use.
  - 1. Refer to Division 01 for acceptance of electronic manuals for this project. If not specified in Division 1, provide manuals in the form of a multiple file composite electronic PDF file for each manual type required. Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size. Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
    - a. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.
  - 2. If Division 01 requires paper manuals, provide four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

#### 1.13 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division

#### 1.14 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a

skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

#### 1.15 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.
- D. Be responsible for the safe storage of tools, material and equipment.

#### 1.16 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.
- D. Also warrant the following additional items:
  - 1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
  - 2. All raceway seals are effective.
  - 3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.
- E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

#### 1.17 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
  - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide

- tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.
    - a. Vent and exhaust fuel-burning heaters per SMACNA Guidelines for Source Control and equip units with individual-space thermostatic controls.
    - b. If permanent HVAC systems are used during construction, provide HVAC Protection and replace all filtration prior to occupancy in accordance with SMACNA Guidelines.

#### 1.18 FIELD CONDITIONS

- A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:
  1. The Drawings describe the general nature of remodeling to the existing building; however, visit the site prior to submitting bid to determine the nature and extent of work involved.
  2. Schedule work in the existing building with the Owner.
  3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves electrical systems, Light fixtures, equipment, raceways, equipment supports or foundations and materials.
  4. Remove articles that are not required for the new work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
  5. Relocate and reconnect electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
  6. Finish material will be installed under other divisions.
  7. Obtain permission from the Contract Administrator for roof penetrations and channeling of floors or walls not specifically noted on the Drawings.
  8. Protect adjacent materials indicated to remain. For work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
  9. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, provide temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
  1. Maintain and protect existing building services that transit the area affected by selective demolition.
  2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- C. Use of explosives is not permitted, unless otherwise specified or allowed for powder-actuated tools.
- D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

### **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 SOIL MATERIALS

- A. Sub base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.
- B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.
- C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than two inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

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

### **3.2 EXISTING CONDITIONS**

- A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new work.
- B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.
- C. Notify Contract Administrator immediately of any dangerous conditions that exist on the job site, as they are discovered, before demolition, during selective demolition or before remodel work begins.

### **3.3 EXISTING UTILITIES**

- A. Prepare and submit a schedule of anticipated utility outages indicating dates and duration. Schedule
- B. Schedule and coordinate with the utility companies, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal utility services from any existing utility line. Include all premium time required for all such work in the bid.
- C. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or utility companies without additional cost.
- D. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.
- E. Make repairs and restoration of utilities before workers leave the project at the end of the workday in which the interruption takes place.
- F. Include in bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

### **3.4 WORK IN EXISTING FACILITIES**

- A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the site prior to submitting a bid, to determine the nature and extent of work involved.
- B. Schedule work in the existing facility with the Owner.
- C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves electrical systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.
- D. Remove all of these articles that are not required for the new work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.
- E. 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 Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.

3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
  4. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.
- F. Relocate and reconnect all electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical fixtures or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.
  - G. Finish materials are specified in other divisions.
  - H. Where removal of existing wiring interrupts electrical continuity of circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued electrical continuity.
  - I. Penetrate roofs, channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all penetrations and channeling not specifically noted on the Drawings.
  - J. Provide new, typewritten card directory for distribution equipment (including but not limited to load centers, panelboards, switchboards and switchgear) where changes occur under this scope of work. Indicate exact loads served by each existing circuit breaker or switch. Where circuit designations are not specifically indicated on the Drawings, provide a unique identifier for each updated circuit within the directory.
  - K. Coordinate work with Architectural phasing drawings to properly stage transitions of work to provide power to existing, new and temporary loads. Monitor loads on distribution system to ensure shifting of loads does not overload electrical equipment.
  - L. Work in common areas, shafts or other Owner owned and/or operated spaces must be reviewed and approved by the Contract Administrator and Owner prior to commencement of the work.

### 3.5 PERMITS

- A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

### 3.6 TEMPORARY ELECTRICAL SERVICE AND WIRING

- A. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.
- B. In existing facilities, with Owner's approval, Contractor may utilize the existing electrical system as the source of temporary power. Coordinate the point of connection and method of connection to the existing system with the Owner's Representative.
- C. Pay all charges made by the Electric Utility, with respect to installation and energy charges for temporary services.
- D. The Owner will pay all charges made by the Electrical Utility, with respect to installation and energy charges for temporary services.
- E. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails, receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.
- F. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.
- G. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120V, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.

- H. Install circuits to points on each level of each building so that service outlets can be reached by a 50-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).
- I. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.
- J. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.
- K. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.
- L. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

### 3.7 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment To Be Salvaged: remove, demount, disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- E. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
  - 1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
    - a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
    - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 26.

### 3.8 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

### 3.9 PENETRATIONS

- A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.



### 3.10 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.
- C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.
- D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.
- E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.
- F. Slope sides of excavations to comply with local, state, and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state, and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
  - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
  - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
  - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
  - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
  - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Excavation for Underground Tanks and Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
  - 1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
  - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches for electrical installations as follows:
  - 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
  - 2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
  - 3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
  5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.
- M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
  2. Under building slabs, use drainage fill materials.
  3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
  4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
  5. Other areas use excavated or borrowed materials.
- O. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
  2. Removal of concrete formwork.
  3. Removal of shoring and bracing, and backfilling of voids.
  4. Removal of trash and debris.
- P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
    - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
  2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material,

compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

### 3.11 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

### 3.12 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.
- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

### 3.13 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Electrical Contractor shall clean material and equipment installed under the Electrical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment.
- C. Damaged finishes shall be touched-up and restored to their original condition

### 3.14 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.
- B. Check motors for alignment with drive and proper rotation, and adjust as required.
- C. Check and test protective devices for specified and required application, and adjust as required.

- D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.
- E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.
- G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.
- H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.
- J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.
- K. Refer to individual sections for additional and specific requirements.

### 3.15 START-UP OF SYSTEMS

- A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.
- B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.
- C. Adjust taps on each transformer for rated secondary voltages.
- D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.
- E. Replace all burned-out lamps. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Owner.
- F. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.
- G. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- H. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

### 3.16 TEST REPORTS

- A. Perform tests as required by these Specifications and submit the results to the Contract Administrator, for Engineer's review. Record the results, date and time of each test and the conditions under which the test was conducted. Include a copy of the finalized test results, with corrections made, in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.
- B. For specific testing requirements of special systems, refer to the Specification section that describes that system. The Contractor shall provide the following to facilitate the testing of the electrical systems:
  - 1. Perform tests as described in the individual sections;

- C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:
  - 1. Building service entrance voltage and amperes at each phase.
  - 2. Electrical service grounding conditions and grounding resistance.
  - 3. Proper phasing throughout the entire system.
  - 4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
  - 5. Phase voltages and amperes at each three-phase motor.
  - 6. Test all wiring devices for electrical continuity and proper polarity of connections.
- D. Promptly correct all failures or deficiencies revealed by these tests in accordance with the manufacturer's recommendations and as determined by the Engineer.

### 3.17 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
  - 1. Submit complete Operation and Maintenance Data.
  - 2. Submit complete Record Drawings.
  - 3. Perform all required training of Owner's personnel.
  - 4. Turn over video recordings of training sessions to the Owner.
  - 5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
  - 6. Perform start-up tests of all systems.
  - 7. Remove all temporary facilities from the site.
  - 8. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.
- B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days notice prior to the review.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, he shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

### END OF SECTION 260010

## SUBSTITUTION REQUEST FORM

To Project Engineer: \_\_\_\_\_ Request # (GC Determined): \_\_\_\_\_

Project Name: \_\_\_\_\_

Project No/Phase: \_\_\_\_\_ Date: \_\_\_\_\_

Specification Title: \_\_\_\_\_

Section Number: \_\_\_\_\_ Page: \_\_\_\_\_ Article/Paragraph: \_\_\_\_\_

Proposed Substitution: \_\_\_\_\_  
\_\_\_\_\_

Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_

Address: \_\_\_\_\_ Phone: \_\_\_\_\_

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: \_\_\_\_\_  
\_\_\_\_\_

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples  
☐ Tests ☐ Reports ☐ Other: \_\_\_\_\_

Reason for not providing specified item: \_\_\_\_\_  
\_\_\_\_\_

Similar Installation:

Project: \_\_\_\_\_ Architect: \_\_\_\_\_

Address: \_\_\_\_\_ Owner: \_\_\_\_\_

Date Installed: \_\_\_\_\_

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Substitution Certification Statement:**

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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**Manufacturer's Certification of Equal Quality:**

I \_\_\_\_\_ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
--	---------------	------------------

**Engineer Review and Recommendation Section**

Recommend Acceptance      ☐ Yes      ☐ No  
Additional Comments:      ☐ Attached      ☐ None

**Acceptance Section:**

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company





## **SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:
  - 1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
  - 2. Sleeves and seals for electrical penetrations.
  - 3. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
  - 4. Sealing penetrations through noise critical spaces.

#### **1.2 DEFINITIONS**

- A. The following abbreviations apply to this and other Sections of these Specifications:
  - 1. AHJ: Authority(ies) having Jurisdiction
  - 2. ATS: Acceptance Testing Specifications
  - 3. EPDM: Ethylene-propylene-diene monomer rubber
  - 4. MC: Metal Clad
  - 5. N/A: Not Available or Not Applicable
  - 6. NBR: Acrylonitrile-butadiene rubber
  - 7. NRTL: Nationally Recognized Testing Laboratory
  - 8. PCF: Pounds per Cubic Foot
- B. The following definitions apply to this and other Sections of these Specifications:
  - 1. Homerun: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

#### **1.3 ADMINISTRATIVE REQUIREMENTS**

- 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, ducts, and other systems installed at required slopes and/or elevations.
  - 4. So connecting raceways, cables, and wireways 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.
- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

#### **1.4 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
  - 1. Product data for the following products:
    - a. Sleeve seals.
    - b. Through and membrane penetration firestopping systems.
    - c. Joint sealers
    - d. Acoustical sealers
  - 2. Shop drawings for:
    - a. Detailed fabrication drawings of access panels and doors.

3. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
  - a. Where Project conditions require modification to qualified testing and inspecting agency's illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
  - b. Qualifications data for testing agency.
4. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26
  - a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

#### 1.5 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.

1. Offices
2. Conference Rooms
3. Classrooms
4. Libraries
5. Patient Care Areas
6. Music Teaching Studios
7. Stage
8. Drama Theaters
9. Choir Risers

## **PART 2 - PRODUCTS AND MATERIALS**

#### 2.1 ACCESS TO EQUIPMENT

- A. Available Manufacturers:
  1. Bar-Co., Inc.
  2. Elmdor Stoneman.
  3. JL Industries
  4. Jay R. Smith Mfg. Co.
  5. Karp Associates, Inc.
  6. Milcor
  7. Nystrom Building Products
  8. Wade
  9. Zurn
- B. Access Doors:
  1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Electrical Systems" for labeling of access doors.
  2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
  3. Access doors must be of the proper construction for type of construction where installed.
  4. The exact location of all access doors shall be verified with the Contract Administrator prior to installation.
  5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
  6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
    - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
    - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
    - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
  7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
  8. Locking Devices:

- a. Flush, screwdriver-operated cam locks.

## 2.2 SLEEVES

- A. Steel sleeves for raceways and cables:
  - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.
- B. Cast iron wall pipe sleeves for raceways and cables:
  - 1. Manufacturers
    - a. Josam Mfg. Co.
    - b. Smith (Jay R) Mfg. Co.
    - c. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
    - d. Watts Industries, Inc.
    - e. Zurn Industries, Inc.; Hydromechanics Div.
  - 2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.
    - a. Underdeck Clamp: Clamping ring with setscrews.
  - 3. Sleeves for rectangular openings: Galvanized sheet steel with minimum 0.052- or 0.138- inch thickness as indicated and of length to suit application.
  - 4. Coordinate sleeve selection and application with selection and application of firestopping to be used.

## 2.3 SEALANTS

- A. SLEEVE SEALS
  - 1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 2. Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. O-Z/Gedney
    - e. Pipeline Seal and Insulator, Inc.
  - 3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.
    - a. EPDM
    - b. NBR
    - c. Neoprene
  - 4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.
    - a. Plastic
    - b. Stainless steel
    - c. PVC-coated steel
  - 5. Connecting Bolts and Nuts: Provide bolts of length required to secure pressure plates to sealing elements. Include one for each sealing element.
    - a. Carbon steel with corrosion-resistant coating
    - b. Stainless steel
- B. JOINT SEALERS
  - 1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
  - 2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.
  - 3. Elastomeric Joint Sealers: Provide the following types:
    - a. Silicone Joint Sealants, One-part nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
      - 1) Dow Corning, Dowsil 790
      - 2) Dow Corning, Dowsil 795
      - 3) GE, Silglaze II SCS 2350
      - 4) GE, Silpruf SCS 2000
      - 5) Owens Corning, Energy Complete
      - 6) Pecora, 864 NST
      - 7) Tremco, Spectrem 1
      - 8) Tremco, Spectrem 2

- b. Mildew Resistant Sealants, one-part mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
      - 1) Dow Corning, Dowsil 786
      - 2) GE, Momentum SCS 1700
      - 3) Pecora, 898 Silicone NST
    - c. Hybrid Joint Sealants: One-part, nonsag, paintable complying with ASTM C 920, Type S, Grade NS, Class 50 recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent. Subject to compliance with requirements, provide one of the following:
      - 1) BASF, MasterSeal NP 100
      - 2) Pecora, DyanTrol I-XL
      - 3) Tremco, Dymonic FC
- C. FIRESTOPPING
  - 1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ. Subject to compliance with requirements, provide one of the following:
    - a. Manufacturers:
      - 1) 3M Corp., Fire Barrier Sealant
      - 2) Hilti, Inc.
      - 3) Tremco, Tremstop Fyre-Sil
      - 4) Pecora, AC-20 FTR
      - 5) RectorSeal
      - 6) Specified Technologies Inc. Firestop
      - 7) USG, SHEETROCK Firecode Compound
      - 8) Owens Corning Firestopping Insulation
- D. ACOUSTICAL SEALANTS
  - 1. General: Penetrations by conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
  - 2. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.
  - 3. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening, permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
  - 4. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m<sup>3</sup>).
  - 5. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90. Meeting ASTM E 84 for a smoke flame spread index of less than 25 / 50. Subject to compliance with requirements, provide one of the following:
    - 1) Pecora, AC-20 FTR
    - 2) Pecora, AIS-919
    - 3) USG, SHEETROCK Acoustical Sealant.

### **PART 3 - EXECUTION**

#### **3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- C. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)
- D. Comply with NECA 1.

- E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.
- F. 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.
- G. 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.
- H. Right of Way: Yield to raceways and piping systems installed at a required slope.

### 3.2 ACCESS DOORS

- A. Verify the exact location, sizes, and types of all access doors with the Contract Administrator prior to purchase.
- B. Provide access doors for all concealed electrical equipment, except where above lay-in ceilings.
- C. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- D. Adjust hardware and panels after installation for proper operation.
- E. Label all access doors with a nameplate as described in Division 26 Section "Identification for Electrical Systems".

### 3.3 SLEEVES AND SLEEVE SEALS

- 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. Provide sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical work that passes through such construction. Coordinate with all other trades and divisions to dimension and lay out all such openings.
- C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other divisions.
- D. New Construction:
  - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support raceway penetrations.
- E. Construction in Existing Facilities:
  - 1. Saw cut or core drill existing walls, roofs and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls, roofs or slabs without first coordinating with, and receiving approval from, the Contract Administrator, Owner, or both. Seal sleeves into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Contract Administrator. Provide roofing penetration seals and covers to match existing roofing materials. Coordinate roofing repair of adjacent roofing material with Owner's roofing contractor to provide a waterproof installation.
- F. 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. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.
- G. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- H. Rectangular Sleeve Minimum Metal Thickness:
  - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
  - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

- I. 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.
- J. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.
- K. Sleeve Length:
  - 1. Sleeves through walls: Cut sleeves to length for mounting flush with both surfaces of walls.
  - 2. Sleeves through floors: Extend sleeves 2 inches above finished floor level.
- L. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed; in which case, size sleeves as recommended by the seal manufacturer.
- M. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- N. 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
- O. 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.
- P. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- Q. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- R. Above Grade Concrete or Masonry Penetrations
  - 1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
    - a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
    - b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.
    - c. Install galvanized sheet metal for rectangular sleeves
    - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
  - 2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant.
- S. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between sleeve and cable or raceway. Provide mechanical sleeve seal.
  - 1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
  - 2. Inspect installed sleeve and sleeve-seal installation for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.
- T. Concrete Slab on Grade Penetrations:
  - 1. Provide 1/2" thick cellular foam insulation around perimeter of raceway passing through concrete foundation. Installation shall extend to 2" above and below the concrete slab.
- U. Elevated Floor Penetrations of waterproof membrane:
  - 1. Provide cast-iron wall pipes for sleeves. Size wall pipe for minimum 1/2" annular space between wall pipe and cable or raceway.
  - 2. Pack with mineral wool and seal both ends with minimum of 1/2" of waterproof sealant.
  - 3. Secure waterproof membrane flashing between clamping flange and clamping ring.
  - 4. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

- V. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.
- W. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.
- X. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.
- Y. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- Z. Sleeve-Seal Installation
  - 1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.
  - 2. 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.
- AA. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.
- BB. Sleeves shall be protected throughout the course of construction, and when damaged shall be replace and/or repaired to a satisfactory condition.

### 3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."
- B. joint sealers
- C. Preparation for Joint Sealers
  - 1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.
  - 2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.
- D. Application of Joint Sealers
  - 1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
    - a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
    - b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
  - 2. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- E. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

### 3.5 ACOUSTICAL PENETRATIONS

- A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway,

through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.

- B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it. After all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

**END OF SECTION 260500**



## **SECTION 260502 - EQUIPMENT WIRING SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This Section includes limited scope for electrical connections to equipment specified under other sections or divisions, or furnished under separate contracts or by the Owner.

#### **1.2 ADMINISTRATIVE REQUIREMENTS**

- A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this contract.
- B. Coordinate with work described in Division 11 Sections for equipment requiring electrical connection.
- C. Coordinate with work described in Division 23 Section "Common Work Results for HVAC".
- D. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- E. Determine connection locations and rough-in requirements based on shop drawings.
- F. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- G. Sequence electrical connections to coordinate with start-up schedule for equipment.

#### **1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products for:
  - 1. Special connectors
  - 2. Special conductors or cable assemblies.
- C. Shop drawings for:
  - 3. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

#### **1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories:
  - 4. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.
  - 5. Marked for intended use.
- B. Comply with NFPA 70.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 CORDS AND CAPS**

- A. Attachment Plugs: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.
- C. Cord: See Paragraph "Flexible Cords" in Division 26 Section "Low-voltage Electrical Power Conductors and Cables".
- D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

### **1.2 INSTALLATION, GENERAL**

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

### **3.2 ELECTRICAL DEVICES**

- A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) as indicated, specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

### **3.3 ELECTRICAL CONNECTIONS**

- A. Make electrical connections in accordance with equipment manufacturers' instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.
- C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

### **3.4 EQUIPMENT**

- A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.
- D. Motorized Damper: Provide lockable toggle, pilot lighted disconnect switch in an accessible location at each motor actuator, or group of motor actuators.

### 3.5 DOOR OPERATORS AND HARDWARE

- A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors, and all other required electrical connections for door systems included in other sections of these specifications.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.
- D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with the NFPA codes.

**END OF SECTION 260502**

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## **SECTION 260504 - PROVISIONS FOR ELECTRIC UTILITY SERVICE**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Provisions for Underground Secondary Electrical Service.
- B. 7General Requirements
- C. Utility service voltage:
  - 1. 208Y/120 volts, three-phase, four-wire, 60 Hz
- D. Utility service ampacity: As indicated on the Drawings.
- E. The extent of Work for the secondary electrical service includes providing the following:
  - 1. Raceways
  - 2. Provisions for Metering
  - 3. Grounding and Bonding
  - 4. Concrete pad for service transformer
  - 5. Service lateral
  - 6. Primary raceways

#### **1.2 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product Data: For the following products:
  - a. Meter bases
- C. Shop Drawings: For the following:
  - a. Utility Company prepared installation drawings
  - b. Cast-in-place concrete pads
- 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.
  - 4. Utility voltage adjustment request.
- E. Where equipment or materials are specified to comply with utility standards and are listed above as required submittals, obtain approval from the serving utility before submitting to the Contract Administrator.
- F. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
  - 1. Accurately record actual routing of interior conduits two-inch and larger trade size and all exterior buried raceway, including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that indicate dimensions from finished grade or other fixed structural elements.

#### **1.3 QUALITY ASSURANCE**

- A. Perform all work in accordance with Utility Company installation drawings and service standards.
- B. Maintain one copy of Utility Company installation drawings and service standards at the site.
- C. Prior to commencing work in this Section, meet with the Utility Company representative to review service entrance requirements and details.
- D. Verify that field measurements are as indicated on Utility Company drawings.

- E. Electrical Components, Devices, and Accessories:
  - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
  - 2. Marked for intended use.
- F. Comply with NFPA 70.

## **PART 2 - PRODUCTS AND MATERIALS**

(Not Used)

## **PART 3 - EXECUTION**

### **3.1 SECONDARY SERVICE ENTRANCE UNDERGROUND**

- A. Provide an underground secondary service lateral from the pad mounted transformer in accordance with NFPA 70 Article 230 and the Utility Company standards. Reference the Drawings for service lateral conductor and raceway quantities, sizes, and types.
- B. The Utility Company will provide the service transformer.
- C. Provide a concrete pad, complying with the Utility Company standards, for transformer mounting, and set coated GRS conduit elbows and riser(s), with grounding bushing(s), to receive primary and secondary raceways. Where direct burial primary is used, set coated GRS conduit elbow(s) and riser(s), with grounding bushing(s), to receive primary cables.
- D. Provide a GRS conduit riser up the Utility Company service pole, including a service weatherhead and any miscellaneous materials, all in accordance with Utility Company standards.
- E. Make connections to the secondary terminals of the transformer as required and in conformance with Utility Company requirements. Utility Company will provide primary conductors and terminal connections unless otherwise directed by the Utility Company.
- F. Provide underground raceways for primary cables from the transformer pad to the property line, and provide pull cord, per Utility Company standards, for the Utility Company's use in pulling primary conductors. Install raceways a minimum of 24 inches below finished grade line unless otherwise indicated on the Drawings or directed by the Utility Company. Provide excavation and backfill as required to accomplish the installation.

### **3.2 METERING**

- A. Provide a 1-1/4-inch empty GRS conduit, with pull cord, from the secondary compartment of the pad-mounted service transformer to the meter location shown on the Drawings, or as directed by Utility Company.
- B. Provide a meter base complying with the Utility Company standards.
- C. The Utility Company will provide the meter and meter wiring.

### **3.3 UTILITY SERVICE CHARGES**

- A. It shall be the responsibility of the Division 26 contractor to apply for the electrical service, including the preparation and completion of all forms. Submit the completed application along with all other required documentation for the new or modified service.
- B. Pay all Utility Company charges for providing electric service, including all charges for bringing primary service conductors to the site.

### 3.4 FIELD QUALITY CONTROL

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
  2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
    - a. Rebalance loads.
    - b. Prepare written request for voltage adjustment by electric utility.
  3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained. Submit results in writing.

**END OF SECTION 260504**





## **SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Conductors, cables, and cords rated 600V and less.
- B. Connectors and terminations rated 600V and less.

#### **1.2 DEFINITIONS**

- A. The following abbreviations apply to this and other Sections of these specifications:
  - 1. MC: Metal Clad
  - 2. NBR: Acrylonitrile-butadiene rubber
  - 3. NETA ATS: Acceptance Testing Specification.
- B. The following definitions apply to this and other Sections of these Specifications:
  - 1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard.
    - a. Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

#### **1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and temperature deration.
  - 2. Coordinate routing of power, low-voltage, and control conduits requiring fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system for power, low-voltage, and control circuit conductors and cables shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:
    - a. Feeders for Emergency Power systems where in areas not protected by an automatic fire suppression system.
    - b. Smokeproof Enclosure Pressurization systems
    - c. Smoke Control systems
    - d. Smoke Removal systems
    - e. Fire service and Occupant Evacuation Elevator systems
  - 3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
  - 4. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
- B. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

#### **1.4 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
  - 1. Product data for the following products:
    - a. Conductors, cables, and cords rated 600V and less.
    - b. Metal Clad (MC) cable and fittings.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

- C. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
- E. Qualification Data: For testing agency.
- F. Field quality-control test reports in accordance with NETA ATS:
  - 1. Submit all system and component test results.
- G. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.
- H. Operation and Maintenance Data: For cable and all accessories to include in operation and maintenance manuals.
- I. Follow-up service reports.

#### 1.5 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.
- C. 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.
- D. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 70.

#### 1.6 PROJECT CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Contract Administrator and obtain direction before proceeding with work.
- 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 Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.
  - 3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
- C. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.

## 1.7 DELIVERY, STORAGE, AND HANDLING

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

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 CONDUCTORS AND CABLES - GENERAL

- A. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable.
  - 1. Solid conductors for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger
  - 2. Stranded conductors
  - 3. Stranded for all flexible cords, cables, and control wiring.
  - 4. As noted otherwise below.
- B. Conductor Material: Compact stranded, aluminum alloy (AA-8000 Series), complying with ICEA S-95-658/NEMA WC70; No. 1 AWG or larger only
- C. Conductor Insulation: Type THHN/THWN-2 or XHHW-2 complying with ICEA S-95-658/NEMA WC70 or as noted otherwise below.
- D. Sizes of conductors and cables indicated or specified are American Wire Gauge (Brown and Sharpe).
- E. Conductors shall not be smaller than No. 12 AWG, with the exception of wiring for signal and pilot control circuits; and pre-manufactured whips for light fixtures which may be No. 14 AWG.
- F. Conductors installed for site electrical work shall be no smaller than No. 10 AWG CU. All site electrical branch circuit wiring shall be sized such that the maximum branch circuit voltage drop is less than 3 percent.
- G. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.
- H. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

### 2.2 SINGLE CONDUCTORS

- A. Available Manufacturers:
  - 1. Alan Wire
  - 2. Cerrowire
  - 3. Colonial Wire & Cable Co., Inc.
  - 4. Encore Wire Corporation
  - 5. General Cable (Prysmian Group)
  - 6. Northern Cables Inc.
  - 7. Okonite Company
  - 8. Southwire Company
- B. 600V, insulated conductors as noted above shall be color-coded as follows, unless noted otherwise:

PHASE	120/240V	208Y/120V
A	Black	Black
B	Red	Red
C	N/A	Blue
Neutral	White	White
Equipment Ground	Green	Green
Isolated Ground	N/A	Green/Yellow Stripe

\*\*Except as provided in NFPA 70.

### 2.3 METAL CLAD CABLE; TYPE MC

- A. General:
  - 1. Shall not be used for life safety or critical systems.
- B. MC Cable (with insulated green grounding conductor, no bonding conductor):
  - 1. Manufacturers:
    - a. Atkore/AFC Cable Systems
    - b. Cerrowire
    - c. Encore Wire Corporation (MC)
    - d. Kaf-Tech
    - e. Northern Cables, Inc.
    - f. Southwire Company (Amorlite)
  - 2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
  - 3. Armor Assembly: Aluminum interlocked armor (aluminum color).
  - 4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
  - 5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NFPA 70.
  - 6. Marking: Cable markings shall comply with the requirements of NFPA 70.
- C. MC Cable (with 0-10V dimming control wiring):
  - 1. Manufacturers:
    - a. Atkore/AFC Cable Systems
    - b. Cerrowire
    - c. Encore Wire Corporation (MC- LED)
    - d. Southwire Company (MC – PCS Duo)
  - 2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
  - 3. Armor Assembly: Aluminum interlocked armor (aluminum color).
  - 4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
  - 5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NFPA 70.
  - 6. Control Conductors: Color-coded Class 2/Class 3 twisted jacketed pairs
  - 7. Marking: Cable markings shall comply with the requirements of NFPA 70.
- D. MC Cable Fittings:
  - 1. Manufacturer & Model:
    - a. ABB/T&B
    - b. Arlington
    - c. Eaton/Crouse-Hinds
    - d. Emerson/O-Z Gedney
  - 2. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.
  - 3. Fittings shall be insulated type not requiring the use of anti-short bushings.
  - 4. Romex style, clamp type fittings are not acceptable.

## 2.4 FLEXIBLE CORDS

- A. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, extra-hard-usage; Type SO for indoor dry and damp locations; SOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.
  - 1. Manufacturers:
    - a. Cerrowire
    - b. Southwire
- B. 300V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, hard-usage; Type SJO for indoor dry locations; SJOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.
  - 1. Manufacturers:
    - a. Cerrowire
    - b. Southwire

## 2.5 CONTROL WIRING

- A. Refer to Division 23 Section "Direct-Digital Control for HVAC"
- B. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

## 2.6 CONNECTORS

- A. Available Manufacturers:
  - 1. AMP; Tyco
  - 2. FCI-Burndy
  - 3. Gould
  - 4. Ideal Industries, Inc.
  - 5. IlSCO
  - 6. NSi Industries, Inc.
  - 7. O-Z/Gedney
  - 8. Panduit
  - 9. Thomas and Betts
  - 10. 3-M Electrical Products Division
- B. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, circumferential compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
  - 1. Termination fittings for copper conductors: Bare copper, 1-hole pad and inspection port.
  - 2. Termination fittings for aluminum conductors: Tinned aluminum, 1-hole pad.
- C. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
  - 1. Termination fittings: Bare copper, 1-hole pad and inspection port.
  - 2. Termination fittings: Tinned aluminum, 1-hole pad.
- D. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts. Color-coded for size, except use green only for grounding connections.
- E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: flanged fork-tongue type.
- F. Connectors and terminations for aluminum conductors and cables No. 1 and larger: UL 486B listed and marked AL7CU for 75 deg C rated conductors and AL9CU for 90 deg C rated conductors.
- G. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

- H. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

### **PART 3 - EXECUTION**

#### **3.1 PREPERATION**

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- B. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)
- C. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.
- D. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).
- E. Where anticipated conductor installed lengths exceed the lengths indicated on the Drawings, notify Contract Administrator. Provide tabulated list of exceeded lengths for review. Increase conductor size, circuit ground size, and conduit size accordingly to meet maximum voltage drop indicated within the calculations.

#### **3.2 INSTALLATION**

- A. General
  - 1. Unless otherwise indicated on the Drawings or in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor at outlets for fixture or device connections.
  - 2. Install in accordance with manufacturer's instructions.
  - 3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
  - 4. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
  - 5. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.
  - 6. Seal around cables penetrating fire-rated elements according to Division 26, Common Work Results For Electrical.
  - 7. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.
  - 8. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
  - 9. Multi-wire branch circuits are not allowed unless noted otherwise on the drawings.
  - 10. Where multi-wire branch circuits are utilized (i.e., shared neutral), shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two examples.
  - 11. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply, which are in addition to those in NFPA 70:
    - a. Emergency Power Circuits – includes all circuits covered under Articles 700, 701 and 702.
      - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.
      - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
    - b. Normal or Non-Essential circuits.
      - 1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: 3/4 inch. For greater than eight conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.
      - 2) The minimum wire size for all conductors in this raceway: No. 10 AWG.

- 3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
  - c. GFCI-protected circuits.
    - 1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.
  12. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.
  13. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.
  14. Branch circuit conductors shall be copper.
  15. All essential power systems circuits shall be copper.
  16. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:
    - a. Wet or dry locations, in raceways:
      - 1) Service entrance: Type THHN/THWN-2, or XHHW.
      - 2) Feeders and branch circuits: Type THHN/THWN-2, or XHHW.
      - 3) Conductors No. 6 AWG and smaller: Types THHN/THWN-2.
    - b. Fluorescent light fixtures or conductors within three feet of high temperature equipment such as heaters: Type THHN, XHHW, or higher temperature insulation as required for the use.
- B. Aluminum Conductor Bid Alternate:
1. Terminations: Tinned, mechanical type only; UL-listed for copper and aluminum conductors at 75 degrees C minimum.
  2. Increase the raceway size as required, at no additional cost to the Owner, to accommodate the increased size of the aluminum conductors.
  3. Aluminum conductor size shall meet or exceed the ampere rating of the scheduled copper conductors at 75 degrees C.
  4. Aluminum option applies only for the following feeders or services with minimum size as indicated in "Conductors and Cables" materials section above. All feeders and services smaller than the minimum size or those not listed below shall be copper:
    - a. Service and feeder conductors may be aluminum unless prohibited below.
      - 1) Exceptions:
        - a) Feeders connecting directly to motors including, but not limited to, chillers and fire pumps shall be copper to minimize loosening of connectors due to cyclical thermal expansion.
      - b. Feeders to switchboards
      - c. Feeders to panelboards
      - d. Feeders to motor control centers
      - e. Feeders to transformers
  5. Where aluminum conductors terminate existing panelboards, switchboards or switchgear that utilize compression connections use hydraulic-compression type connectors with a zinc base, anti-oxidizing compound. Use compression tools of the type that will not release unless the correct pressure has been applied.
  6. Measure the temperature of all aluminum conductors at all splices and terminations. Make each test under typical building load conditions after the building is occupied and in operation for a minimum of two weeks. Replace all joints or splices indicating excessive heating.
  7. Take measurements with a non-contact type infrared thermometer, with target size not exceeding one inch at five feet and an accuracy of two percent or better. Submit the meter specifications and calibration date with the test results.
- C. Metal Clad Type MC Cable:
1. Securing and Supporting:
    - a. Support per NFPA 70 for MC cable
    - b. Secure cable within 12 inches of every box or fitting.
    - c. Secure/supporting intervals shall not exceed six (6) feet for MC cable.
    - d. Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible so as to provide for cable routing in a neat and workmanship like manner.
  2. Type MC cable may only be used:
    - a. In lieu of flexible conduit and wiring from light fixtures in accessible ceilings to junction boxes (attached to building structure) above the ceiling. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.

- b. In lieu of metal raceway, only for 15A and 20A branch circuits with up to four (4) conductors, not including grounding and/or bonding conductor(s), and only in dry concealed locations above grade, except where specifically not permitted by NFPA 70.
  - 3. MC cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:
    - a. Unjacketed MC:
      - 1) In locations not permitted by NFPA 70.
      - 2) When specifically not allowed by the local AHJ and/or Owner.
      - 3) Concealed within walls.
      - 4) Homeruns to panelboards.
      - 5) Where exposed to view.
      - 6) Where subject to physical damage.
      - 7) Corrosive or Hazardous locations.
      - 8) Wet locations.
      - 9) Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
      - 10) Within mechanical, electrical or telecommunication equipment rooms.
      - 11) Emergency circuits covered by NFPA 70.
- D. Flexible Cords
  - 1. Refer to Division 26 Section, "Equipment Wiring Systems", for electrical connections to equipment.
- E. Control Wiring
  - 1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
  - 2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or otherwise specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.
    - a. Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.
- F. Connections:
  - 1. Apply a zinc based, anti-oxidizing compound to connections.
  - 2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
  - 3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
  - 4. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
  - 5. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.
  - 6. Use connectors as indicated in equipment schedules. Where not indicated use connections as noted below.
    - a. Mechanical – where temporary removal is required
  - 7. Do not use terminals on wiring devices to feed through to the next device.

### 3.3 IDENTIFICATION

- A. General: Provide all identification per Division 26 "Identification for Electrical Systems".
- B. Single Conductors: Identify and color-code conductors to indicate voltage and phase according to Part 2 of this Section. Identification method shall be either:
  - 1. Factory provided colored insulation
  - 2. Color-Coding Conductor Tape.
  - 3. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- C. Power-Circuit Conductor Identification: For primary and secondary conductors 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes identify voltage, source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box identify each ungrounded conductor according to voltage, source and circuit number.



- E. Conductors to Be Extended in the Future: Attach identification device to conductors and list source and circuit number.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- G. Conductors for controls (lighting, controls): Label each conductor with Markers for Conductor and Control Cables. – identify conductors using method as noted in Division 26 Section "Identification for Electrical Systems". Note conductor identification on record Drawings.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- I. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- J. Low voltage cable sheath labels and related manufacturer information shall remain apparent in all exposed applications.
  - 1. Protect exposed cabling labels from painting and overspray (this includes protection of cables in cable tray)

#### 3.4 FIELD QUALITY CONTROL

- A. Do not perform insulation resistance tests of the distribution wiring to equipment with the surge protective devices installed. Disconnect surge protective device before conducting insulation resistance tests and reconnect immediately after the testing is over.
- B. Testing: Perform the following field quality-control testing:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.
  - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

**END OF SECTION 260519**



## **SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. This Section includes:
  - 1. Grounding Electrodes
  - 2. Grounding Conductors
  - 3. Connector Products
  - 4. Miscellaneous Grounding Materials and Products

#### **1.2 DEFINITIONS**

- A. The following apply to this and other Sections of these Specifications:
  - 1. Ground ring: Bare underground grounding conductor encircling the building or structure.
  - 2. NETA ATS: Acceptance Testing Specification.
  - 3. PSF: Pounds per Square Foot
  - 4. EMT: Electrical metallic tubing.
  - 5. ENT: Electrical nonmetallic tubing.
  - 6. FMC: Flexible metal conduit.
  - 7. GRS: Galvanized Rigid Steel Conduit
  - 8. IMC: Intermediate metal conduit.
  - 9. LFMC: Liquidtight flexible metal conduit.
  - 10. LFNC: Liquidtight flexible nonmetallic conduit.
  - 11. RAC: Rigid Aluminum Conduit
  - 12. RMC: Rigid Metal Conduit
  - 13. RNC: Rigid nonmetallic conduit.

#### **1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
  - 1. Product data for the following products:
    - a. Electrodes, mechanical and compression connectors, and exothermic connectors .
- B. Qualification Data: For Contractor.
- C. 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. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
  - 1. Accurately record actual locations of all buried electrodes, bonding conductors and ground rings. Indicate dimensions from fixed structural elements.

#### **1.4 QUALITY ASSURANCE**

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

- C. Testing Agency Qualifications: An independent testing 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.
- D. Electrical Components, Devices, and Accessories:
  - 1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 2. Marked for intended use.
  - 3. Comply with UL 467.
- E. Comply with NFPA 70.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:**

- A. Available Manufacturers:
  - 1. ABB, Inc.
  - 2. Advanced Lightning Technology (ALT)
  - 3. AFL Global
  - 4. Boggs, Inc.
  - 5. Burndy; Hubbell.
  - 6. Cooper Power; Eaton.
  - 7. Copperweld Corp.
  - 8. ECN/Korns; Division of Robroy Industries.
  - 9. Erico; nVent.
  - 10. Galvan Industries, Inc.
  - 11. Greaves Corp.
  - 12. Harger.
  - 13. Hastings Fiber Glass Products, Inc.
  - 14. Heary Brothers Lightning Protection Co.
  - 15. Ideal Industries, Inc.
  - 16. ILSCO.
  - 17. Lightning Master Corp.
  - 18. Lyncole XIT Grounding; Division of VFC.
  - 19. O-Z/Gedney Co.; Emerson.
  - 20. Panduit, Inc
  - 21. RACO; Hubbell, Inc.
  - 22. Robbins Lightning, Inc.
  - 23. Superior Grounding Systems, Inc.

### **2.2 GROUNDING ELECTRODES**

- A. Ground Rods: UL-listed:
  - 1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
  - 2. Size: 5/8 inch by 8 feet. Provide sectional types when longer rods are indicated.
- B. Ground Plates: UL-listed, rectangular, bare solid copper plate; minimum 0.032-inch thick.
- C. Ground Ring:
  - 1. Bare copper grounding conductor, size as noted on Drawings but not less than #2/0 AWG.

### **2.3 GROUNDING CONDUCTORS**

- A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
- B. Material:
  - 2. Aluminum.
  - 3. Copper-clad aluminum.
  - 4. Copper.

- C. Equipment Grounding Conductors: Insulated and identified as indicated in Part 3 of this section.
- D. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
- E. Underground Conductors:
  - 5. Bare-copper conductor.
  - 6. No. 2/0 AWG minimum
  - 7. Stranded, unless otherwise indicated.
- F. Bare Copper Conductors:
  - 1. Solid Conductors: Comply with Conductors: ASTM B 8.
  - 2. Tinned Conductors: Comply with ASTM B 33.
- G. Copper Bonding Conductors:
  - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
  - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
  - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.

## 2.4 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors.
- C. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
  - 8. Company symbol and/or logo.
  - 9. Catalog number.
  - 10. Conductors accommodated.
  - 11. Installation die index number or die catalog number is required.
  - 12. Underwriters Laboratories "Listing Mark:".
  - 13. The words "Suitable for Direct Burial" or, where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467.
- D. Cast connectors: copper base alloy according to ASTM B 30.
- E. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

## 2.5 MISCELLANEOUS

- A. Test Wells:
  - 1. Traffic Areas: Polymer concrete reinforced with heavy weave fiberglass; H-20 load rating; minimum 24 inches deep.
  - 2. Non-traffic Areas: High density polyethylene; 350 PSF minimum load rating; minimum 10.25 inches deep.
  - 3. Cover: Factory-identified by permanent means with word "GROUND".
- B. Ground Enhancing Backfill: Provide low-resistivity, ground-enhancing backfill material recommended by the electrode manufacturer.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Contract Administrator and the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

#### **A. General:**

- 14. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of NFPA 70 and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.
- 15. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.
- 16. Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

#### **B. Application:**

- 17. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- 18. Underground Grounding Conductors: Unless noted otherwise, bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

#### **B. Grounding Electrode System: Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.**

- 1. Provide continuous grounding electrode conductors without splice or joint.
- 2. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
- 3. Ground Rod Electrodes:
  - a. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
  - b. Unless otherwise indicated, install ground rod electrodes vertically.
    - 1) Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
    - 2) Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
  - c. 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. If depth is unachievable, notify Contract Administrator and Engineer.
  - d. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
  - e. Verify that final backfill and compaction has been completed before driving rod electrodes.
  - f. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade, pavement, or floor.
- 4. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches. Use exothermic weld to secure grounding electrode conductor.
- 5. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- 6. Metal In-Ground Support Structures: Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.

#### **C. Equipment Grounding Conductors:**

- 1. Comply with NFPA 70, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- 2. Install equipment grounding conductors in all feeders and branch circuits.

3. In branch circuit and feeder raceways, use insulated equipment grounding conductors.
  4. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
  5. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components. On water heaters, bond metal hot and cold water pipes together, across the heater tank.
- C. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
6. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ground bar.
  7. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- D. Bonding: Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70:
1. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
  2. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
  3. Bond metallic elements likely to become energized or where indicated on the Drawings, including but not limited to fences around electrical equipment and metal drain bodies near pools or electrical equipment.
  4. Bond raised flooring systems and static control flooring.
  5. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
  6. Pole Mounted Luminaires: Bond metal enclosures and components of pole mounted luminaires to the grounding system per the Manufacturer's requirements.
  7. Bond the components within the following systems to the building grounding system:
    - a. Metallic Cable Tray Systems.
    - b. Photovoltaic Systems.

### 3.3 CONNECTIONS

- E. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  2. Make connections with clean, bare metal at points of contact.
  3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- F. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:
1. Connecting conductors together.
  2. Connecting conductors to ground rods, except at test wells.
  3. Connecting conductors to building steel.
  4. Connecting conductors to plates.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

1. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:
  - a. Connecting conductors together.
  - b. Connecting conductors to building steel.
  - c. Connecting conductors to ground rods, except at test wells.
- H. Mechanical Pressure-Type Connections: Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
  1. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:
    - a. Connecting conductors to ground rods at test wells.
    - b. Connecting conductors to pipes.
- I. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- J. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- K. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.
- L. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- M. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- N. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise encircling the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade, or 6 inches below the official frost line, whichever is greater, and 6 inches from the foundation.

### 3.5 IDENTIFICATION

- A. Provide identification as specified in Division 26 "Low-Voltage Electrical Power Conductors and Cables" and "Identification for Electrical Systems".

### 3.6 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
  1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
  2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
  3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
  4. Inspect and test in accordance with NETA ATS, except Section 4.



5. Perform inspections and tests listed in NETA ATS, Section 7.13.
6. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
7. Perform point-to-point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
8. Test Values:
  - a. The resistance between the main grounding electrode and earth ground shall be no greater than 10 ohms.
  - b. Equipment Rated 500 kVA and Less: 10 ohms.
  - c. Equipment Rated 500 to 1000 kVA: 5 ohms.
9. Minimum system neutral-to-ground insulation resistance: one megohm.
10. Investigate point-to-point resistance values that exceed 0.5 ohms.
  - a. Check for loose connections.
  - b. Check for absent or broken connections.
  - c. Check for poor quality welds.
  - d. Consider other reasons.
11. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements
12. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.
13. Submit detailed reports indicating inspection and testing results and corrective actions taken.

### 3.7 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

### 1.2 EXISTING INSTALLATIONS

- A. Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Where applicable, verify the neutral and ground are properly bonded at the point of service entrance. Notify the Owner and the Engineer of any existing deficiencies.

### END OF SECTION 260526



## **SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

#### **1.2 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

#### **1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
  - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
  - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
  - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 5. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
  - 6. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
  - 7. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Structural members in path of conduit groups with supports.
  - 2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.
- C. Sequencing:
  - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  - 1. Submit fabrication drawings and product literature.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

## 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
  - 2. Rooftop support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel slotted channel systems. Include Product Data for components.

## 1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70 and applicable building code.
- B. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

## **PART 2 - PRODUCTS**

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. General:
  - 1. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
- B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly. Use corrosion resistant materials suitable for the environment where installed.
  - 1. Available Manufacturers:
    - a. Allied Tube & Conduit; Atkore International.
    - b. Eaton
    - c. Erico; nVent.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Atkore International.
    - g. Wesanco, Inc.
  - 2. Metallic Coatings:
    - a. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
  - 3. Channel Dimensions: Selected for applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
  - 1. Conduit Straps: One-hole or two-hole type.
  - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder or Battery-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - a. Manufacturers:
    - 1) Hilti Inc.
    - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    - 3) MKT Fastening, LLC.
    - 4) Powers Fasteners, Inc;
    - 5) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
  - a. Available Manufacturers:
    - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
    - 2) Empire Tool and Manufacturing Co., Inc.
    - 3) Hilti Inc.
    - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

H. Wire Rope Hanging Systems:

1. Manufacturers:
  - a. Gripple.
2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
4. Wire Rope: Zinc coated, stainless steel or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.
5. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

## 2.2 FABRICATED METAL CONDUIT OR EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.
- C. Rooftop support assemblies: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane.
  1. Conduit supports: Unless noted otherwise, surface mounted fittings not requiring any attachment to the roof structure and not penetrating the roofing assembly with support fixtures.
  2. Equipment supports: Attachment fittings for connection to roof structure.
- D. Base Sizes: As required to prevent overturning and to distribute load sufficiently to prevent indentation of roofing assembly.
- E. Mounting Height: Provide minimum clearance of 6 inches under supported components to top of roofing.

## **PART 3 - EXECUTION**

### **3.1 APPLICATION**

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Unless specifically indicated or approved by the Contract Administrator and Structural Engineer, do not support from roof deck.
- C. Where support wires are permitted, identify independent electrical component support wires above accessible ceilings with color distinguishable from ceiling support wires in accordance with NFPA 70.
- D. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
  - 1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
  - 2. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
- E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:
  - 1. Spacing supports for EMT, IMC, and RMC shall be as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70.
- F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with:
    - a. single-bolt conduit clamps using spring friction action for retention in support channel
- G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- H. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Supported load shall not exceed manufacturer's recommended load rating.

### **3.2 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Install in accordance with manufacturer's instructions.
- E. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- F. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
  - 1. 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.
- G. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
- H. Do not use products for applications other than as permitted by NFPA 70 and product listing.

- I. Remove temporary supports when no longer required.
- J. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- K. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
    - a. Instead of expansion anchors, powder or battery-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  - 5. To Steel:
    - a. Spring-tension clamps.
  - 6. To Light Steel: Sheet metal screws.
  - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- L. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.
- D. Minimize overhanging materials and protrusions, and provide protective caps and fittings on exposed material ends where:
  - 1. Accessible to untrained personnel.
  - 2. Located within confined spaces.
- E. Rooftop support assemblies:
  - 1. Conduit supports: Unless noted otherwise, coordinate installation of support system after roofing materials are complete. Provide adhesive materials to secure conduit supports where required. Where attachment to roof structure is required or otherwise specified, coordinate installation of supports with roofing material installation.
  - 2. Equipment supports: Coordinate installation of supports with roofing material installation.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 "Concrete".
- C. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Comply with requirements in Division 09 "Finishes" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- D. Inspect support and attachment components for damage and defects. Correct deficiencies and replace damaged or defective support and attachment components.

**END OF SECTION 260529**



## **SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SECTION INCLUDES**

- A. This Section includes:
  - 1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

#### **1.2 DEFINITIONS**

- A. Terminology used in this specification is as defined below:
  - 1. EMT: Electrical Metallic Tubing
  - 2. FMC: Flexible Metal Conduit
  - 3. GRS: Galvanized Rigid Steel Conduit
  - 4. IMC: Intermediate Metal Conduit
  - 5. LFMC: Liquidtight Flexible Metal Conduit
  - 6. RAC: Rigid Aluminum Conduit
  - 7. RMC: Rigid Metal Conduit
  - 8. RNC: Rigid Nonmetallic Conduit
  - 9. RTRC: Reinforced Thermosetting Resin Conduit

#### **1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate the work with other trades to avoid placement of raceway, boxes, or other potential obstructions within the dedicated equipment spaces and working clearances for equipment installed by other trades in accordance with the codes and manufacturer requirements.
  - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
  - 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
  - 5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
  - 6. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated. Coordinate the work with other trades to preserve insulation integrity.
  - 7. Coordinate routing of power, low-voltage, and control conduits requiring fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system for power, low-voltage, and control circuit conductors and cables shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:
    - a. Feeders for Emergency Power systems where in areas not protected by an automatic fire suppression system.
    - b. Smokeproof Enclosure Pressurization systems
    - c. Smoke Control systems
    - d. Smoke Removal systems
    - e. Fire service and Occupant Evacuation Elevator systems

#### **1.4 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Structural members in path of conduit groups with supports.
  - 2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

- C. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
  - 1. Accurately record actual routing of all exterior buried raceway and all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.

## 1.5 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Electrical Components, Devices, and Accessories:
  - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
  - 2. Marked for intended use.
- C. Comply with NFPA 70.

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

- A. Metal Conduit
  - 1. Available Manufacturers:
    - a. ABB, Inc.
    - b. Atkore
    - c. American Conduit
    - d. Anamet Electrical, Inc.
    - e. Electri-Flex Co.
    - f. Nucor Tubular Products.
    - g. O-Z/Gedney Co.; Emerson.
    - h. Southwire Company, LLC
    - i. Western Tube and Conduit Corporation.
    - j. Wheatland Tube Co.
  - 2. RMC:
    - a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.
      - 1) Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.04 inches (1mm), minimum.
    - b. RAC: ANSI C80.5, UL6A.
  - 3. IMC: ANSI C80.6, UL 1242.
    - a. Plastic-Coated IMC and Fittings: NEMA RN 1, UL-listed.
  - 4. EMT and Fittings: ANSI C80.3, UL 797. Only steel products allowed. Reduced wall EMT is not allowed.
    - a. Fittings: Set-screw or Compression type.
  - 5. FMC: Zinc-coated steel: UL 1. Reduced wall FMC is not allowed.
  - 6. LFMC: Flexible steel raceway with PVC jacket: UL 360.
    - a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Nonmetallic Raceway
  - 1. Available Manufacturers:
    - a. ABB, Inc.
    - b. American Pipe and Plastics, Inc.
    - c. Anamet Electrical, Inc.
    - d. Atkore
    - e. Cantex Inc.
    - f. Carlon
    - g. Champion Fiberglass, Inc.
    - h. Electri-Flex Co.
    - i. Hubbell Inc. (Fittings)
    - j. IPEX USA, LLC.
    - k. Prime Conduit.
    - l. Southwire Corporation.

- m. Superflex Ltd.
    - n. United Fiberglass of America, Inc.
  - 2. RNC: Schedule 40 PVC: NEMA TC 2, UL 651.
    - a. Fittings: match to raceway and tubing type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
  - 3. ENT: NEMA TC 13, UL-listed.
    - a. Fittings: match to tubing type and material: NEMA TC 13, NEMA TC 6, UL 651, as applicable.
  - 4. LFNC: UL 1660.
    - a. Fittings: match to tubing type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
  - 5. RTRC (Fiberglass): UL 2420 UG, UL 2515 AG, NEMA TC 14; SW (Standard Wall), HW (Heavy Wall) or XW (Extra Heavy Wall)
- C. Metal Wireways
  - 1. Available Manufacturers:
    - a. BEL Products, Inc.
    - b. Cooper B-Line; Eaton.
    - c. EPI-Electrical Enclosures
    - d. Hoffman.
    - e. Square D.
  - 2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA 1, 3R, 12, or 4X.
  - 3. Fittings and Accessories: Include couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.
  - 4. Wireway Covers:
    - a. Hinged type
  - 5. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.
- D. Surface Metal Raceways
  - 1. Manufacturers:
    - a. ABB, Inc.
    - b. Hubbell, Inc.
    - c. Legrand.
    - d. Mono-Systems; Niedax Group
    - e. Panduit Inc.
  - 2. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
  - 3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

## 2.2 BOXES, ENCLOSURES AND CABINETS

- A. General
  - 1. Available Manufacturers:
    - a. ABB, Inc.
    - b. American Midwest Power
    - c. Appleton/O-Z Gedney Co.; Emerson.
    - d. BEL Products, Inc.
    - e. Cooper Crouse-Hinds; Eaton.
    - f. Erickson Electrical Equipment Co.
    - g. FSR, Inc.
    - h. Hoffman.
    - i. Hubbell, Inc.
    - j. Legrand.
    - k. Molex; Koch Industries.
    - l. Robroy Industries, Inc.; Enclosure Division.
    - m. Spring City Electrical Manufacturing Co.
  - 2. Provide products listed, classified, and labeled as suitable for the purpose intended. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
  - 3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.

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. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
  2. Cast Metal Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover. Furnish with threaded hubs.
    - a. List and label as complying with UL 514A for non-hazardous locations;.
    - b. List and label as complying with UL 886 for hazardous locations, where required.
  3. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
  4. 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.
  5. Boxes for Ganged Devices: Use multi-gang boxes of single-piece construction. Do not use field-connected gangable boxes.
  6. Minimum Box Size, Unless Otherwise Indicated:
    - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
    - b. Communications Systems Outlets: Comply with Section 27 10 05.
    - c. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
    - d. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
  7. Do not use "through-wall" boxes designed for access from both sides of wall.
  8. Wall Plates: Comply with Division 26 Section "Wiring Devices".
- C. Boxes for telephone, data, telecommunications and audio-video outlets, refer to:
1. Division 27 Section "Common Work Results for Communications"
- D. Junction and Pull Boxes Larger Than 100 cubic inches:
1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, and list and label as complying with UL 514A.
  2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron or aluminum with gasketed cover.
  3. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
  4. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
  5. Terminal Blocks: Where indicated on the Drawings, provide terminal blocks with voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
- E. Cabinets and Enclosures:
1. General:
    - a. Compliance: NEMA 250, and list and label as complying with UL 50 and UL50E or 508A, as applicable.
    - b. NEMA 250 Environment ratings:
      - 1) NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.
      - 2) NEMA Type 3R: Code-gauge galvanized steel with drip shield top, seam-free front, side, and back; non-gasketed continuous-hinged door, with stainless steel pin; captive, plated steel cover screws; hasp and staple for padlocking; collar studs.
        - a) Removable painted steel interior panel mounted on standoffs; metal barriers to separate wiring of different systems and voltages.
    - c. Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.
    - d. Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring. Provide wire management troughs where practicable.
    - e. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

## 2.3 FACTORY FINISHES

- A. Finish: All interior components shall be factory finished; manufacturer's standard grey unless otherwise noted.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

#### **A. General**

1. Install in accordance with manufacturer's instructions

### **3.2 RACEWAYS**

#### **A. General**

1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.
2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 3/4 inch (concealed and exposed); 1 inch (underground and under slab).
  - a. 1/2 inch conduit shall contain maximum (5) #12AWG conductors or (3) #10AWG conductors.
  - b. 3/8 inch flexible conduit may be used for light fixture whips.
3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.
4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.
5. Install grounding bushings on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.
6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Contract Administrator, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.
7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
8. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
10. Install raceways:
  - a. To meet the requirements of the structure and the requirements of all other Work on the Project.
  - b. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
  - c. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.
  - d. Parallel or perpendicular to building lines or column lines.
  - e. Tight to structure.
  - f. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
11. Raceways Embedded in Slabs:
  - a. Raceways may only be embedded in concrete slabs with written permission from, and only where directed, by the Structural Engineer.
  - b. Install in middle 1/3 of slab thickness, where practical. At a minimum, concrete shall provide at least 2 inches of concrete cover for raceways.
  - c. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  - d. Space raceways laterally to prevent voids in concrete.
  - e. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  - f. Change from RNC to coated GRS or IMC before rising above the floor.
12. Where masonry walls are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.
13. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section "Hangers and Supports for Electrical Systems". Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.
  - a. Raceways on roof shall be supported from structure not from the roof deck.

14. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:
  - a. Attach single raceway directly to structural steel with beam clamps.
  - b. Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.
  - c. Attach groups of raceways to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.
  - d. Attach groups of raceways to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.
  - e. Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.
  - f. Hang horizontally suspended groups of raceways using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.
  - g. Support conductors in vertical raceway in accordance with NFPA 70 requirements.
  - h. Cross-brace suspended raceway to prevent lateral movement during seismic activity.
  - i. Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.
15. Install electrically and physically continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flaking the finish.
16. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Contract Administrator's approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.
17. Align and install raceway terminations true and plumb.
18. Complete raceway installation before starting conductor installation.
19. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.
20. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints; or where structures providing a means of support are subject to relative movement greater than acceptable by the raceway manufacturer.
21. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Contract Administrator, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Contract Administrator, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.
22. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.
  - b. Where otherwise required by NFPA 70.
23. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment as required by other requirements of the construction documents.; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
24. Maintain 2" minimum spacing from bottom of roof deck to prevent raceway penetrations from above
25. Do not route conduits across skylights, access panels, hatched tiles, HVAC diffusers, or equipment working space.
26. Route conduits serving rooftop equipment concealed inside the equipment curb and minimize roof penetrations and exterior conduit runs where practicable.
27. Install all underground conduits/raceways a minimum of 24" below the bottom of slab/paving/grade, unless noted otherwise, where practicable.
28. Provide boxes and raceways for the fire protection system low voltage wiring as required. This includes low voltage wiring exposed less than 96" AFF.
  - a. At a minimum, provide 3/4" conduit.
  - b. Coordinate requirements and locations with system installer and fire alarm specifications.

B. RMC

1. Use GRS or IMC in the following areas:
  - a. Where indicated.
  - b. For Emergency Feeders.
  - c. Exterior applications where above grade and exposed.
  - d. Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.
  - e. All raceways penetrating slabs on grade (use plastic-coated raceway or provide with a corrosion resistant approved mastic coating). This shall include the 90-degree elbow below grade and the entire vertical transition to above grade.
  - f. Conductors over 600 volts.
  - g. Concealed within masonry walls.
  - h. Damp or wet locations.
  - i. Crawl spaces
  - j. Interior spaces where exposed to damage. Includes but is not limited to the following areas.
    - 1) Loading dock
2. Use RAC in the following areas:
  - a. Indoors above grade.
  - b. Interior wet or damp locations.
3. Do not use RAC:
  - a. Below grade.
  - b. Imbedded in concrete or other areas corrosive to RAC.

C. EMT

1. Use EMT in the following areas:
  - a. Where indicated.
  - b. Interior concealed locations for:
    - 1) Branch circuits.
    - 2) Feeders.
    - 3) Emergency branch circuits.
    - 4) Low-voltage control, security, and fire alarm circuits
  - c. Exposed where not subject to physical damage
    - 1) Mechanical rooms
2. Do not use EMT:
  - a. Below grade.
  - b. In exterior applications when exposed.

D. FMC and LFMC

1. Use FMC or LFMC:
  - a. For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.
  - b. From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.
  - c. Use FMC only in dry locations
  - d. Use LFMC in damp, wet, corrosive, outdoor locations.
2. Do not use FMC or LFMC:
  - a. For branch circuits, homeruns or feeders.
  - b. In lengths exceeding 6 feet.

E. RNC

1. Solvent-weld RNC fittings and raceway couplings per the manufacturer's instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.
2. Where installed exposed outdoors or other areas subject to temperature variations, install expansion fittings per NFPA 70, to accommodate thermal expansion in straight runs.
3. RNC is only allowed to be used in the following locations:
  - a. Where specifically indicated.
    - 1) If an adopted code prevents use of RNC in a location where the contract documents specifically allow its use, contractor shall utilize other types of conduit allowed by the specification.
    - 2) Allowed does not mean required.
  - b. Underground, single and grouped, in lieu of GRS or IMC, when indicated.
    - 1) Direct buried

- 2) Concrete-encased (use approved rigid PVC interlocking spacers, selected to provide minimum duct spacing and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts).
  - c. Vertical risers on utility poles
    - 1) Schedule 80
    - 2) Only upon Utility Company approval
- F. Telephone and Signal/Data System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

### 3.3 RACEWAY FITTINGS:

- A. Compatible with raceways and suitable for use and location.
- B. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.
- C. PVC Externally Coated, Rigid Steel Conduits: Use only fittings and installation tools approved by the manufacturer for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits. Replace all fittings and conduits that have any portion of the coating scraped off to bare metal, at no additional cost to the Owner.
- D. Join raceways with fittings designed and approved for that purpose and make joints tight.
- E. Use insulating bushings to protect conductors at raceway terminations:
  - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
  - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

### 3.4 WIREWAYS:

- A. Use flat head screws, clips and straps to fasten wireways to surfaces. Mount plumb and level.
- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Close ends of wireway and unused raceway openings.

### 3.5 BOXES:

- A. General
  - 1. Verify locations of device boxes prior to rough in.
  - 2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.
  - 3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.
  - 4. Install boxes to preserve fire ratings of walls, floors, and ceilings.
  - 5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.
  - 6. Support boxes independently of raceway.
  - 7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.
  - 8. Adjust flush-mounted boxes to make front edges flush with finished wall material.
  - 9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.
  - 10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.
- B. NEMA Enclosure ratings: Suitable for the environment in which it is installed. At a minimum, provide the following ratings:
  - 1. NEMA 250, type 3R
    - a. Provide at exterior locations



2. NEMA 250, type 1
  - a. Provide at interior and dry locations
3. NEMA 250 type 4 stainless steel
  - a. Provide at interior damp or wet locations
  - b. Provide at interior locations where associated device is labeled as Weather Proof and/or Weather Resistant, unless requirement below already requires box to be rated otherwise.
4. NEMA 250 type 4X
  - a. Provide at interior locations subject to corrosion

C. Outlet Boxes

1. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Contract Administrator. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.
2. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.
3. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
4. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
5. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
6. Use cast aluminum boxes where aluminum rigid metal conduit is used.
7. Use nonmetallic boxes where exposed rigid PVC conduit is used.
8. Use suitable concrete type boxes where flush-mounted in concrete.
9. Use suitable masonry type boxes where flush-mounted in masonry walls.
10. Use raised covers suitable for the type of wall construction and device configuration where required.
11. Use shallow boxes where required by the type of wall construction.
12. Install extension and plaster rings as required by NFPA 70.
13. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.
14. Do not exceed allowable fill per NFPA 70.
15. Where multiple devices are shown grouped together, gang mount with a common cover plate.

D. Junction and Pull Boxes

1. Install junction and pull boxes above accessible ceilings and in unfinished areas.
2. Provide boxes set flush in painted walls or ceilings with primer coated cover.
3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.
4. Boxes for exterior use shall be:
  - a. PVC with a UV-stabilized PVC cover sealed and gasketed watertight.
  - b. Cast aluminum with a cast aluminum cover sealed and gasketed watertight.
  - c. Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.
  - d. Install buried boxes so that box covers are flush with grade, unless indicated otherwise.

3.6 CABINETS AND ENCLOSURES:

- A. Unless otherwise indicated on the Drawings, provide
  1. NEMA 1 construction for indoor, dry locations
  2. NEMA 12 for indoor, damp and dusty locations
  3. NEMA 3R for outdoor locations
  4. NEMA 4X for indoor wet and corrosive locations
- B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.
- C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.

- D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.
- E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.
- F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

### 3.7 IDENTIFICATION

- A. Refer to Division 26 Section "Identification for Electrical Systems" for identification materials.
- B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identification device shall be:
  - 1. Self-adhesive vinyl label
- C. Accessible Raceways of Auxiliary Systems: Identify the following systems using the same identification device as other accessible raceways 600V or less, and with the indicated color scheme for each system:
  - 1. Fire Alarm System: Red.
  - 2. Fire-Suppression Supervisory and Control System: Red and yellow.
  - 3. Combined Fire Alarm and Security System: Red and blue.
  - 4. Security System: Blue and yellow.
  - 5. Mechanical and Electrical Supervisory System: Green and blue.
  - 6. Telecommunication System: Green and yellow.
  - 7. Control Wiring: Green and red.
- D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- E. Junction Boxes and Pull Boxes:
  - 1. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

### END OF SECTION 260533

## **SECTION 260923 - LIGHTING CONTROL DEVICES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This Section includes the following lighting control devices:
  - 1. Line-voltage dimming wall switches.
  - 2. Line-voltage wall switch occupancy sensors.
  - 3. Line-voltage dimming wall switch occupancy sensors.
  - 4. Line-voltage occupancy sensors.
  - 5. Line-voltage photoelectric switches.
  - 6. Stand-Alone Low-voltage occupancy sensors.
  - 7. Stand-Alone Low-voltage photoelectric switches.
  - 8. Stand-Alone Low-voltage power packs.
  - 9. Stand-Alone Low-voltage switches.
  - 10. Conductors and Cables for Lighting Control Devices.

#### **1.2 DEFINITIONS**

- A. Acoustic Type: Occupancy sensor detection type that detects occupancy by listening for acoustic noises.
- B. Closed loop: Photosensor control algorithm designed for influence by both daylight and electric light in a space or area.
- C. DPDT: Double pole, double throw.
- D. DPST: Double pole, single throw.
- E. Dual-Technology Type: Occupancy sensor detection type that detects occupancy by using a combination of PIR and ultrasonic or acoustic detection technologies.
- F. LED: Light-emitting diode.
- G. Open loop: Photosensor control algorithm designed for influence by daylight entering in a space or area.
- H. PIR Type: Passive infrared. Occupancy sensor detection type that detects occupancy by sensing a combination of infrared heat and movement.
- I. SPST: Single pole, single throw.
- J. Ultrasonic Type: Occupancy sensor detection type that detects occupancy by sensing a change in pattern of reflected ultrasonic energy.

#### **1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

#### **1.4 SUBMITTALS**

- A. Product data for the following products:
  - 1. Catalog cut sheets, including major and minor motion coverage patterns sensors, time delay and sensitivity adjustability settings, load restrictions, and performance specification items indicating compliance with this specification for all lighting control devices.
- B. Shop Drawings:

1. Occupancy sensors and photoelectric switches
  - a. Show installation details.
  - b. Lighting plan showing location, mounting height, orientation and coverage area of each sensor and coordination with other trades.
  - c. Interconnection diagrams showing field-installed wiring.
  - d. Include diagrams for power, signal, and control wiring.
  - e. For any manufacturer submitted other than that listed as the Basis of Design, provide the following information for Engineer review:
    - 1) Factory-generated occupancy sensor and photoelectric switch layouts on project lighting plans with sensor location, orientation and product type clearly marked on plans. Sensor placement shall be coordinated with project reflected ceiling plan layout, ceiling heights, lights, diffusers, and any other ceiling devices and equipment.
    - 2) List of any deviations to this specification or Basis of Design products.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. Occupancy sensors and photoelectric switches:
  - a. Manufacturer's installation instructions, including instructions for storage, handling, protection, examination, preparation, start-up calibration and installation.
  - b. Product data clearly showing sensor field adjustments, including dip switch setting definitions and location of settings within sensors.
  - c. Manufacturer's maintenance, including operating and adjustment instructions.

## 1.5 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. Occupancy sensors and photoelectric switches
  1. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of 5 years.
  2. Products shall be manufactured by an ISO 9001 certified manufacturing facility.
  3. Manufacturer shall test all equipment prior to shipment.

## 1.6 WARRANTY

- A. Manufacturers shall provide a five (5) year warranty for sensors and accessories from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.1 GENERAL INFORMATION

- A. PIR type requirements:
  1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
  2. Sensor shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
  3. Sensor shall provide high immunity to false triggering from RFI and EMI.
  4. Sensor shall have a multiple-segmented fresnel lens in a multiple-tier configuration, with grooves to eliminate dust and residue buildup. Sensor shall be capable of accepting mask inserts to mask specific portions of the lens to prevent false triggering.
- B. Ultrasonic type requirements:
  1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

2. Detection Frequency (Small Area – 500 sq ft and less): Ultrasonic operating frequency shall be crystal controlled at 40 kHz within +/- 0.005% tolerance to assure reliable performance and eliminate sensor cross-talk.
  3. Detection Frequency (Medium and Large Areas – greater than 500 sq ft): Ultrasonic operating frequency shall be crystal controlled at 32 kHz within +/- 0.005% tolerance, to assure reliable performance and eliminate sensor cross-talk.
  4. Sensors shall be capable of automatically adapting to airflow conditions or filtering frequency spectrum related to air movement.
- C. Acoustic type requirements:
1. Detector Sensitivity: Acoustic type technology shall only be used as secondary to PIR in a Dual-Technology Type sensor. Specific sensitivity is based on PIR technology.
  2. Sensors shall distinguish noises made by human activity (typing, talking, eating, etc.) and filter out noises made by the environment or building (HVAC, equipment, cars, etc.).
  3. Acoustic technology shall enhance reliability and accuracy of PIR sensor.
- D. Dual-Technology type requirements:
1. Dual-Technology sensors using ultrasonic technology shall have field-selectable controls on unit to determine if a particular technology or combination of technologies controls the on-off function.
  2. Dual-Technology sensors using acoustic technology shall have the PIR technology initially detect motion and a combination of PIR and acoustic technologies shall keep the load on.
  3. Sensitivity Adjustment: Separate for each sensing technology.
  4. Different LED indicator colors for each sensing technology
  5. PIR sensor component shall comply with all requirements listed under PIR type requirements.
  6. Ultrasonic sensor component shall comply with all requirements listed under Ultrasonic Type requirements.
  7. Acoustic sensor component shall comply with all requirements listed under Acoustic Type requirements.

## 2.2 LINE-VOLTAGE DIMMING WALL SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. Dimmer shall be suitable for dimmed load type of connected light fixture. Load types shall be as indicated on Drawings and confirmed per load type for connected luminaire as indicated in Light Fixture Schedule and approved light fixture and dimmer shop drawings.

## 2.3 LINE VOLTAGE WALL SWITCH OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C), unless indicated elsewhere for specific model and application.
  3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
  4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.
    - a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
    - b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of the switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.
  5. Operation adjustment: Concealed, field-adjustable for auto-on or manual-on operation.
  6. Time Delay adjustment:

- a. Concealed, field-adjustable.
  - b. Time delay for de-energizing loads shall be adjustable with multiple increments from 30 seconds up to 30 minutes.
- 7. Adaptive technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
- 8. Mounting: Single-gang wall box switch
- 9. Finish: Sensor finish shall be as directed by the Architect.
- 10. Sensor:
  - a. Vandal-resistant lens
  - b. Integral sliding blinders or pre-cut tape strips to block sensor views
  - c. Protrudes no greater than 0.50 inches from wall.
  - d. 180-degree field of view
  - e. Major and minor motion coverage patterns confirmed per Nema WD7 guidelines.
  - f. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.
- 11. Indicators:
  - a. LED indicator for visual detection of motion
  - b. audible and/or visual alerts for pending shut-off
- 12. Suitable for switching load types used, including LED, fluorescent, incandescent, magnetic and electronic low voltage and motor load types. UL listed and labeled, zero-cross relay, no minimum load requirement, ground wire.
- 13. Wall switch shall have no leakage of current to load and integral service switch to permit a maintained off for servicing of lamps for safety purposes
- 14. Buttons/Relays: Provide control relay and push button quantities as indicated by model listed in Lighting Control Device Schedule.
- 15. Restriction on leakage to grounding conductor.
  - a. For new construction: Dual-technology wall switch sensor shall have not more than 0.5ma leakage of current to ground per UL requirements. Provide and connect a neutral conductor to these devices.

#### 2.4 LINE-VOLTAGE DIMMING WALL SWITCH OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors:
  - 1. Comply with all requirements listed under Line-Voltage Dimming Wall Switches in this specification and,
  - 2. Comply with all requirements listed under Line-Voltage Wall Switch Occupancy Sensors in this specification.

#### 2.5 LINE-VOLTAGE OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors. Integral relay unit for line voltage sensors.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. UL Listed for dry locations and complies with local codes.
  - 3. Operation: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Upon occupancy of space, loads shall turn on. If occupancy is not detected within the time delay period, loads shall de-energize. Time delay for de-energizing loads shall be adjustable over a minimum range of 1 to 15 minutes with a maximum of 30 minutes.
  - 4. Switch Rating: As indicated in Lighting Control Device Schedule.
  - 5. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.
  - 6. Mounting: Suitable for mounting in any position on a standard outlet box.

7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
8. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.
9. Bypass Switch: Override the "on" function in case of sensor failure, concealed on unit to prevent tampering.
10. Finish: Sensor finish shall be as directed by the Architect.
11. Operating temperatures: Unless indicated otherwise for specific models, 32 degree F through 104 degree F, and relative humidity of 0%-95%.
12. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.
13. Device shall include isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems as indicated on the Drawings
14. Device and related relays shall be compatible with the specific load types controlled.
15. Sensor:
  - a. Coverage pattern: As indicated in Lighting Control Device Schedule, and shall have been confirmed with NEMA WD7 Guide and Robotic test method.
  - b. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.

## 2.6 LINE-VOLTAGE PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. Outdoor:
  1. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
    - a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photoelectric switch to prevent fixed light sources from causing turn-off.
    - b. Time Delay: 15-second minimum, to prevent false operation.
    - c. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
    - d. Mounting: Base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

## 2.7 STAND-ALONE LOW-VOLTAGE OCCUPANCY/VACANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensor unit, for use with a separate stand-alone low-voltage power pack containing a line-voltage relay.
  1. Occupancy sensors and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
  2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  3. UL Listed for dry locations and complies with local codes.
  4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.
    - a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
    - b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of a separate, associated switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.
  5. Switch Rating: As indicated in Lighting Control Device Schedule.
  6. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.

7. Mounting: Suitable for mounting in any position on a standard outlet box.
8. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
9. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.
10. Bypass Switch: Override the "on" function in case of sensor failure, concealed on unit to prevent tampering.
11. Finish: Sensor finish shall be as directed by the Architect.
12. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.
13. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.
14. Sensors:
  - a. Sensor shall be compatible with lighting control system.
  - b. Sensors shall be capable of being combined with additional sensors to achieve adequate coverage.
  - c. Sensor coverage pattern: AS indicated on Lighting Control Device Schedule, and shall have been confirmed with Nema WD7 Guide and Robotic test method.
  - d. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.

## 2.8 STAND-ALONE LOW-VOLTAGE PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for switches: Ceiling-mounted, solid-state indoor photoelectric switch, for use with a separate stand-alone low-voltage power pack, containing a line-voltage relay.
  1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
  2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  3. UL Listed for dry locations and complies with local codes.
  4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Upon ambient light level measurement reading below setpoint, loads shall be de-energized. Upon ambient light level measurement reading above setpoint, loads shall be energized.
  5. Finish: Sensor finish shall be as directed by the Architect.
- C. Indoor:
  1. Photoelectric switches shall be Open Loop or Closed Loop as indicated on the Lighting Control Device Schedule on the Drawings.
  2. Description: Solid state, low voltage with contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the lighting control system or as indicated on the Drawings.
    - a. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
    - b. Time Delay: 30-second minimum, to prevent false operation.
    - c. Mounting: Twist lock complying with IEEE C136.10, with base.

## 2.9 STAND-ALONE LOW-VOLTAGE POWER PACKS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for power packs: Box mounted, solid-state indoor power pack/relay unit, for use with a separate stand-alone low-voltage sensor and switches.



1. Power packs and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. UL Listed for dry locations and complies with local codes.
4. Unit shall include isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems as indicated on the Drawings
5. Relay shall be compatible with the specific lighting types controlled.
6. Operations: Refer to drawings for Sequence of Operations or other operational instructions. Unit operates in conjunction with other system components. Refer to operations requirements of associated devices.
7. Switch Rating: As indicated in Lighting Control Device Schedule.  
Mounting: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

#### 2.10 STAND-ALONE LOW-VOLTAGE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for switches: Wall-mounted, solid-state indoor manual switch, for use with a separate stand-alone low-voltage power pack, containing a line-voltage relay.
  1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
  2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  3. UL Listed for dry locations and complies with local codes.
  4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Manual push of any button shall energize or de-energize loads.
  5. Mounting: Suitable for mounting in any position on a standard outlet box.
  6. Indicator: LED, for each button to indicate when loads are energized and de-energized.
  7. Finish: Sensor finish shall be as directed by the Architect.
  8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

#### 2.11 CONDUCTORS AND CABLES FOR LIGHTING CONTROL DEVICES

- A. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.
- B. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG.
- C. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG.
- D. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG.
- E. Provide all necessary conductor and cabling required for operation of the controls and control systems specified. This includes power and control wiring required for the controls to operate as described.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

- A. GENERAL
  1. Install devices and associated power packs and wiring in accordance with manufacturer's instructions and applicable codes.

**B. LINE VOLTAGE WALL SWITCHES**

1. Install dimming wall switches to achieve full rating specified on Lighting Control Device Schedule taking into account de-rating for ganging as instructed by the manufacturer.
2. Provide a separate grounded (neutral) conductor for each circuit controlled by a line voltage switch.
  - a. Do not share neutral conductor on load side of dimmers.
  - b. If neutral termination is not required for the device, cap conductor and tag as "Neutral for future use".

**C. OCCUPANCY/VACANCY SENSORS AND PHOTOELECTRIC SWITCHES**

1. Arrange a pre-installation meeting with manufacturer's factory authorized field representative, at Owner's facility, to verify placement of sensors and installation criteria.
2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage areas specified in manufacturer's literature. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas that are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective areas.
3. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems and partition assemblies.
4. Occupancy sensors with ultrasonic or dual-technology sensing technologies shall be located not closer than 4 feet from the nearest edge of air supply devices or similar obstructions that would adversely affect the sensor performance.
5. Adjust time delay setting of occupancy sensors to de-energize loads after space has been unoccupied for period of time indicated on the Drawings.
6. Install outdoor photoelectric switches with clear view of the northern sky unless noted otherwise on the Drawings.
7. Adjust settings of photoelectric switches to turn on lighting at illumination level indicated on the Drawings.
8. Install devices and auxiliary equipment in compliance with manufacturer's instructions and recommendations.
9. Install relay units where concealed from view and where accessible.
10. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
11. Install switchbox mounted occupancy sensors at same elevation as other lighting control switches.

**D. WIRING**

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch (19 mm).
2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

**3.2 IDENTIFICATION**

- A. General:** Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."
- B. Power and control wiring:** Identify using marker tapes.
1. Identify controlled circuits in lighting contactors.
  2. Identify circuits or luminaires controlled by photoelectric switches and occupancy sensors at each sensor.
- C. Components:** Label each component with self-laminating computer printed labels, using a unique designation matching control drawing.
- D. Cover plates:** Refer to drawings for labeling requirements of certain cover plates for manual switches, or similar devices, requiring labeling for user information.

- E. Buttons/switches:
  - 1. Engraved from manufacturer. Refer to drawings for detailed requirements and text for labeling.
  - 2. As indicated on drawings.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
  - 2. Operational Test: Test all occupancy sensors in test mode to confirm sensor coverage and sensitivity of sensor per manufacturer's instructions. Upon completion of tests, set sensor time delay as indicated on Lighting Control Device Schedule. Follow testing and adjustment procedures as written in the manufacturer's installation instructions for each sensor model.
- B. Lighting control devices that fail tests and inspections are defective work. Remove, replace, and retest devices that fail tests.

### 3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- B. Photoelectric switch Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project for this purpose.

### 3.5 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Lighting Control Systems."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training" for additional information

### **END OF SECTION 260923**



## **SECTION 262416 - PANELBOARDS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY:**

- A. This section includes panelboards rated 600 V and less, including the following:
  - 1. Lighting and appliance branch-circuit panelboards.
  - 2. Disconnecting and Overcurrent Protective Devices.

#### **1.2 DEFINITIONS**

- A. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.
- B. SVR: Suppressed voltage rating.
- C. SPD: Surge Protection Device

#### **1.3 ADMINISTRATIVE REQUIREMENTS**

- 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.

#### **1.4 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product Data: For each type of panelboard, switching and overcurrent protective device, furnished accessories and components. Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.
- C. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
    - a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 2. Detail enclosure types and details for other than NEMA 250, Type 1.
  - 3. Include general arrangement drawing showing dimensions and weights of each assembled section.
  - 4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
  - 5. Detail short-circuit current rating of panelboard assembly and overcurrent protective devices.
  - 6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
  - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 8. Include schematic and wiring diagrams for power, signal, and control wiring.
  - 9. Include nameplate legends.
  - 10. Include list of materials.
- D. Field Quality-Control 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. Sample Warranty: For warranty.
- F. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

- G. Panelboard Schedules: Submit final panelboard directories.
- H. 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. Routine maintenance requirements for panelboards and all installed components.
  - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
  - 4. Features and operating sequences, both automatic and manual.
- I. Follow-up service reports.

#### 1.5 QUALITY ASSURANCE

- A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

#### 1.6 PROJECT CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
- B. 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 equipment 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 (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
    - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet (2000 m).
- D. Interruption of Existing Electric Service: Do not interrupt electric service to occupied facilities. Refer to Division 26 Section "General Electrical Requirements" for allowable outages.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of equipment to allow movement into designated space.
- B. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.
- C. Handle and prepare panelboards for installation according to NEMA PB 1 and manufacturer's written instructions. Use factory-installed lifting provisions.

## 1.8 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components and/or products of the panelboards that fail in materials or workmanship within the specified warranty period.
- B. Warranty Period: Three years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.1 GENERAL

- A. Manufacturers:
  - 1. ABB Inc.
  - 2. Eaton.
  - 3. Schneider Electric.
  - 4. Siemens Energy & Automation, Inc.
- B. Enclosures: Flush- or surface-mounted cabinets as noted.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
  - 2. Hinged Front Cover: Entire front trim hinged to box.
  - 3. Door: Standard door with concealed hinges, within hinged trim cover. Secured with vault-type latch with tumbler lock; keyed alike.
  - 4. Finishes:
    - a. 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.
    - b. Back Boxes: Galvanized steel.
  - 5. Directory Card: Inside panelboard door, mounted in transparent card holder.
- C. Incoming Mains Location: Top and/or bottom as required.
- D. Buses: Three phase, four wire unless otherwise indicated.
  - 1. Phase, and Neutral Buses:
    - a. Material:
      - 1) Hard-drawn copper, 98 percent conductivity.
    - b. Size: Ampacity as indicated on drawings, with uniform capacity for entire length of panelboard's sections.
      - 1) Neutral bus: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus
  - 2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
    - a. Material: Hard-drawn copper, 98 percent conductivity
    - b. Size: Minimum-size required by UL 67
  - 3. General: Provide any available breaker mounting space with bussing.
- E. Line-Side Conductor Connectors (Lugs):
  - 1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
  - 2. Material: Same as bus material.
  - 3. Capacity rating: Same as associated bus.
  - 4. Type: Provide mechanical type unless otherwise indicated on Drawings, refer to schedules and one-line diagram.
  - 5. Provide properly sized lugs for all equipment, circuit breakers and other electrical devices to accommodate installed conductors. A larger frame, oversized lugs or non-standard product may be required in some instances.
    - a. Pin adapters may be utilized only as allowed by manufacturer and the authority having jurisdiction.

- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Short-Circuit Current Rating (SCCR):
  - 1. Rating value: Rated to withstand symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings. SCCR shall not be less than the highest AIC rating of any circuit breaker in panelboard.

## 2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: Circuit breaker type: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: As indicated on drawings.
- C. Branch Overcurrent Protective Devices:
  - 1. Connection to bus: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
  - 2. Type: Provide types as indicated on drawings and as defined below.
- D. Device Ratings:
  - 1. Continuous ampere rating: as indicated on drawings.
  - 2. Voltage and frequency rating: same as panelboard.
  - 3. Short-circuit current rating (SCCR): Same as requirements for panelboard.
  - 4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

## 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Arc Flash Mitigation
  - 1. Overcurrent devices, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
- B. Ratings:
  - 1. Continuous ampere rating: as indicated on drawings.
  - 2. Voltage and frequency rating: same as panelboard.
  - 3. Short-circuit current rating (SCCR): Same as requirements for panelboard.
  - 4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. 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.
  - 2. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  - 3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  - 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  - 5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  - 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical type unless otherwise indicated on Drawings, 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: Relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      - 1) Mounting: Integral
    - e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.



- f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
  - g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- E. Fuses are specified in Division 26 Section "Fuses."

## 2.4 IDENTIFICATION

- A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine panelboards before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.
- B. Examine areas, surfaces, substrates, and elements to receive panelboards with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that field measurements are as indicated.
  - 2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine roughing-in of conduits and grounding systems to verify the following:
  - 1. Wiring entries comply with layout requirements.
  - 2. Entries are within conduit-entry tolerances specified by manufacturer.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1 and manufacturer's instructions.
- B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Wall-Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panelboards not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Mount top of trim 72 inches (1788 mm) above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
- G. Install fuses in fusible devices.
- H. Install filler plates in unused spaces.
- I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
  - 1. Empty conduits shall be provided with pull strings.
  - 2. Cap and label empty conduits for future use.

- J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- K. Comply with NECA 1.

### 3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

### 3.4 IDENTIFICATION

- A. Equipment Nameplates: Label each contiguous main, or entrance, section with equipment nameplate.
- B. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate.
- C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- D. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.
  - 1. Exception: Do not install NFPA 70 working clearance requirements on flush panelboards and similar equipment in finished spaces.
- E. Panel Directories
  - 1. 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.
  - 2. Note the date the directory was created/updated.
  - 3. Create directory after loads have been balanced to reflect actual as-built conditions.
  - 4. Circuit descriptions shall be per code and shall be distinguishable from all others.
  - 5. Replace existing directories with revised type written directories indicating changes.

### 3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

### 3.6 PROTECTION

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

### 3.7 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

### 3.8 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control tests and inspections:
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.
- B. Acceptance Testing Preparation:
  - 1. After installing equipment but before equipment is energized, test for compliance with requirements.
  - 2. Verify that grounding system at the equipment tested at the specified value or less.
  - 3. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
  - 4. Test continuity of each circuit.

- C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
  2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
  4. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the main incoming section of each service entrance panelboard. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
  2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
    - a. Rebalance loads.
    - b. Prepare written request for voltage adjustment by electric utility in accordance with Division 26 section "Provisions for Electric Utility Service".
  3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**END OF SECTION 262416**



## **SECTION 262726 - WIRING DEVICES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Receptacles: Single, duplex, twist-lock, ground-fault circuit interrupters (GFCI), and tamper resistant (TR).
  - 2. AC Wall Switches: Single- and double-pole, three- and four-way, maintained and momentary.
  - 3. Device Wall Plates.

#### **1.2 DEFINITIONS**

- A. GFCI: Ground-fault circuit interrupter.
- B. IG: Isolated Ground
- C. PIR: Passive Infrared.
- D. RFI: Radio Frequency Interference
- E. SPD: Surge Protective Device
- F. USB: Universal Serial Bus
- G. TR: Tamper Resistant

#### **1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products:
  - 1. Provide manufacturer's catalog information specifically marked to indicate which devices are being furnished, and showing dimensions, colors, and configurations for all devices, including, but not limited to: Receptacles, AC wall switches, and cover plates.
- C. Shop drawings for:
  - 1. List of legends and description of materials and process used for pre-marking wall plates.
- D. Field quality-control test reports.

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.
- B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.
- C. Electrical Components, Devices, and Accessories:
  - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
  - 2. Marked for intended use.
- D. Comply with NFPA 70.

## 1.5 COORDINATION

- A. Receptacles for Equipment Furnished by Owner or Under Other Divisions or Contracts: Match plug configurations.

## 1.6 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. Wall Plates: One for every 10 of each type (i.e., style, size, and finish) installed, but no fewer than two of each type.

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 GENERAL

- A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, special purpose receptacles, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

### 2.2 MANUFACTURERS

- A. Manufacturers:
  - 1. Receptacles and Switches:
    - a. Eaton.
    - b. Hubbell Incorporated.
    - c. Legrand.
    - d. Leviton.
- B. In other Part 2 articles below, where manufacturers and device catalog numbers are included, the following additional requirements apply to product selection:
  - 1. Product manufacturer and model numbers listed are to establish the quality of the wiring devices. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers listed in individual articles below, in addition to those listed in Paragraph "Manufacturers" above.
  - 2. Coordinate the proper suffixes in order to provide the correct color as specified below.

### 2.3 FINISHES

- A. Color:
  - 1. Wiring devices connected to normal power systems: As selected by Architect, unless otherwise indicated or required by NFPA 70. Cover plates: Stainless steel.

### 2.4 CONVENIENCE RECEPTACLES

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A.
- B. Duplex tamper resistant convenience receptacles: Commercial Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.  
Basis of Design: Legrand TR20.

### 2.5 GFCI RECEPTACLES

- A. Ground fault circuit interrupter type tamper and weather-resistant receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and

feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

Basis of Design: Legrand 2097TRWR

- B. Ground fault circuit interrupter with Blank Face: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

Basis of Design: Legrand 2085.

## 2.6 SPECIAL/MISCELLANEOUS DEVICES

- A. Special purpose receptacles: Grounding type, UL listed with NEMA configurations as indicated below or on the Drawings.

Basis of Design:	Legrand:
Dryer 14-30R	3864
Range 14-50R	3849
Switch/Receptacle Combo	671
Clock 5-15R	S3733

## 2.7 SWITCHES

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide switches equivalent to those specified for 20A, but rated for 15A.

- B. Switches: Heavy Duty Specification grade, rated for 120/277V, 20A, back and side wired, and UL listed and labeled.

Basis of Design: Legrand:

1 pole	PS20AC1
2 pole	PS20AC2
3-way	PS20AC3
4-way	PS20AC4

- C. Key operated light switches: Same as standard light switches except toggle handle shall be operated by a factory provided key.

Basis of Design: Legrand:

1 pole	PS20AC1-L
2 pole	PS20AC2-L
3-way	PS20AC3-L
4-way	PS20AC4-L

## 2.8 COVER PLATES

- A. Wet Location Weatherproof Receptacle Cover Plates (Outlet Box Hood): NEMA 3R weather resistant recessed or flush mount, die cast aluminum lockable cover. Configure cover for horizontal mounting of receptacle or as indicated otherwise. Back box must be suitable for conduit connections. Coordinate back box with wall depth.

Basis of Design: Leviton IUM1H-GY.

- A. Damp and Wet Location Weatherproof switch cover plates: Fabricated of cast aluminum or cast zinc, sealed water-tight and UL listed for wet locations.

Basis of Design: Appleton FSK.

- B. Other locations: Single and combination types to match corresponding wiring devices and manufacturer of wiring devices specified herein.

1. Plate securing screws: Metal with head color to match finish plate.
2. Material for Finished Spaces: Brushed stainless steel Type 302.
3. Material for Unfinished Spaces and surface mounted wiring devices: Galvanized steel.
4. Masonry walls and oversized wall openings: Jumbo size plates with same material as indicated above.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the Contract Administrator.
- B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.
- C. Provide twist-locking type receptacles or other special type receptacles where indicated on the Drawings.

#### **3.2 EXAMINATION**

- A. Verify existing conditions prior to beginning work.
- B. Verify that outlet boxes are installed at proper height and are flush with the finished surface.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

#### **3.3 PREPARATION**

- A. If required, provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from in and around outlet boxes.

#### **3.4 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.
- C. Connect wiring devices by wrapping conductors around screw terminals. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box. Exception: Do not bond grounding terminals of isolated ground receptacles to the outlet box.
- E. Install devices shown on wood trim, cases or other fixtures symmetrically and, where necessary, set with the long dimensions of the plate horizontal, or ganged in tandem.
- F. Unless dimensioned otherwise, install wiring devices a minimum of 24 inches from the closest edge of any sink.
- G. Install switches with OFF position down.
- H. Install cover plates on all switches, receptacles, and blank outlets.
- I. Locate wiring devices so that the cover plate does not have to be cut to be installed.
- J. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.
- K. Install cover plates after the wall has been finished (painted, wall paper, etc).



- L. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
- M. Provide ground fault circuit interruption capability for all 120V receptacles 50A or less and all 208/240V receptacles 100A or less in code required locations. Locations include, but are not limited to: bathrooms, kitchens/food prep areas, exterior locations and within 6' of sinks. Interruption capability can be achieved via a GFCI circuit breaker or a GFCI receptacle.
- N. Install wiring devices shown back-to-back on a common wall offset a minimum of 12" horizontally to reduce sound transmission between rooms.
- O. Provide safety-type, tamper-resistant receptacles in all areas where receptacles are mounted less than 5'-6" AFF and are easily accessible to children.

### 3.5 MOUNTING HEIGHTS

- A. Coordinate locations of outlet boxes provided under Division 26 Section "Common Work Results for Electrical".
- B. Unless noted otherwise, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.
  - 1. Receptacles:
    - a. General:
      - 1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.
      - 2) Where Installed horizontally, install neutral slot mounted at the top.
    - b. Above counters:
      - 1) Mount vertically.
    - c. Mechanical and electrical equipment rooms and janitors closets:
      - 1) Mount horizontally.
    - d. Weatherproof exterior receptacles:
      - 1) Mount horizontally.
    - e. GFCI receptacles: Same as general receptacles.
    - f. Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.
  - 2. Switches:
    - a. Above counters: Same as for receptacles.
    - b. Concrete Block Walls: Dimension may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom of boxes are at block joints.
    - c. Walls with wainscoting: 6 inches minimum above wainscoting, but not exceeding 48 inches above finished floor.
  - 3. Telephone/Data Outlet Boxes:
    - a. General: Match mounting height of adjacent wiring device listed above.

### 3.6 IDENTIFICATION

- A. Label all devices fed down stream of GFCI protected receptacles as "GFCI PROTECTED".
- B. Comply with Division 26 Section "Identification for Electrical Systems."
  - 1. Receptacles and Switches: Identify panelboard and circuit number from which served, using:
    - a. Hot, stamped or engraved machine printing with black-filled lettering on face of plate.
    - b. Permanent-ink marker, hand-printed legibly, inside outlet boxes.

### 3.7 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
- D. Test all wiring devices for electrical continuity and proper polarity of connections.

- E. Test each GFCI receptacle device for proper operation.
- F. Correct wiring devices incorrectly installed.
- G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.8 ADJUSTING

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

3.9 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

**END OF SECTION 262726**

## **SECTION 262813 - FUSES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Cartridge fuses rated 600-V ac and less for use in:
    - a. Control circuits
    - b. Enclosed switches

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
- B. Operation and Maintenance Data: For fuses 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. All items requested under "Product Data".

#### **1.3 QUALITY ASSURANCE**

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248.

#### **1.4 PROJECT CONDITIONS**

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### **1.5 COORDINATION**

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.
- B. Coordinate location of and access to spare fuse cabinet(s) with final electrical equipment layouts within electrical equipment rooms.

#### **1.6 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.

### **2.2 MANUFACTURERS**

- A. Manufacturers:
  1. ABB Ltd.
  2. Eaton Corporation Plc
  3. Mersen Electrical Power
  4. Littelfuse, Inc.
  5. Schneider Electric SE
  6. Siemens AG

### **2.3 CARTRIDGE FUSES**

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

### **2.4 ACCESSORIES**

- A. Provide the following accessories where indicated or where required to complete installation:
  1. Fuseholders: Compatible with indicated fuses.
  2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Do not install fuses until circuits are ready to be energized.
- B. Install in accordance with manufacturer's instructions.
- C. Install fuses in fusible devices. Arrange fuses so manufacturer, type and rating information is readable without removing fuse.

### 3.3 FUSE APPLICATIONS

- A. Cartridge Fuses:
  - 1. Service Entrance:
    - a. Greater than 600A:
      - 1) Class L, time delay
    - b. 600A or less:
      - 1) Class RK1, time delay
  - 2. Feeders:
    - a. Greater than 600A:
      - 1) Class L, time delay
    - b. 600A or less:
      - 1) Class RK1, time delay
  - 3. Motor Branch Circuits:
    - a. Class RK1 time delay
  - 4. Other Branch Circuits:
    - a. Class RK1, time delay
  - 5. Control Circuits:
    - a. Class CC fast acting

### 3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

**END OF SECTION 262813**



## **SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This section includes enclosed switches and circuit breakers rated 600 V and less, including the following:
  - 1. Fusible switches.
  - 2. Non-fusible switches.
  - 3. Enclosures.

#### **1.2 DEFINITIONS**

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

#### **1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordinate layout and installation of enclosed switches, circuit breakers 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.

#### **1.4 SUBMITTALS**

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.
- C. Shop Drawings: For enclosed switches and circuit breakers.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
    - a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 2. Detail enclosure types and details for other than NEMA 250, Type 1.
  - 3. Include general arrangement drawing showing dimensions and weights of each assembled section.
  - 4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
  - 5. Detail short-circuit current rating of enclosed switch or circuit breaker assembly and overcurrent protective devices.
  - 6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
  - 7. Include schematic and wiring diagrams for power, signal, and control wiring.
  - 8. Include nameplate legends.
  - 9. Include list of materials.
- D. Qualification Data: For qualified testing agency.
- E. Field quality-control 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.

F. Sample Warranty: For warranty.

G. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

H. 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. Routine maintenance requirements for enclosed switches, circuit breakers and all installed components.
2. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
3. Time-current curves; include selectable ranges for each type of overcurrent protective device.
4. Features and operating sequences, both automatic and manual.

I. Follow-up service reports.

#### 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

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. 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.

E. Comply with NFPA 70.

#### 1.6 PROJECT CONDITIONS

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

B. Environmental Limitations:

1. Do not deliver or install enclosed switches and circuit breakers until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment 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 less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
  - b. Altitude: Not exceeding 6600 feet (2010 m).

C. Interruption of Existing Electric Service: Refer to Division 26 section "General Electrical Requirements"

#### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of equipment to allow movement into designated space.

B. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

C. Handle and prepare enclosed switches and circuit breakers components according to manufacturer's written instructions. Use factory-installed lifting provisions.



## 1.8 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components and/or products of the enclosed switches and circuit breakers that fail in materials or workmanship within the specified warranty period.
- B. Warranty Period: Three years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.1 FUSIBLE SWITCHES

- A. Manufacturers:
  - 1. ABB Inc.
  - 2. Eaton.
  - 3. Schneider Electric.
  - 4. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.

### 2.2 NONFUSIBLE SWITCHES

- A. Manufacturers:
  - 1. ABB Inc.
  - 2. Eaton.
  - 3. Schneider Electric.
  - 4. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Lugs: Mechanical type, suitable for number, size, and conductor material.

### 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. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

### 2.4 IDENTIFICATION

- A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine enclosed switches and circuit breakers before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.
- B. Examine areas, surfaces, substrates, and elements to receive enclosed switches and circuit breakers with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that field measurements are as indicated.
  - 2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine roughing-in of conduits and grounding systems to verify the following:
  - 1. Wiring entries comply with layout requirements.
  - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install enclosed switches and circuit breakers and accessories in accordance with manufacturer's instructions.
- B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Wall-Mounted Switches: Install enclosed switches and circuit breakers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For enclosed switches and circuit breakers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Mount equipment plumb and rigid without distortion of enclosure.
- E. Install fuses in fusible devices.
- F. Comply with NECA 1.

### **3.3 CONNECTIONS**

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

### **3.4 IDENTIFICATION**

- A. Equipment Nameplates: Label each section with equipment nameplate.
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- C. Warning Labels: Label equipment with a warning label in accordance with NFPA 70 and NFPA 70E.
  - 1. Exception: Do not install NFPA 70 working clearance requirements on enclosed switches and circuit breakers in finished spaces.

### 3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

### 3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

### 3.7 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control tests and inspections:
- B. Acceptance Testing Preparation:
  - 1. After installing equipment but before equipment is energized, test for compliance with requirements.
  - 2. Verify that grounding system at the equipment tested at the specified value or less.
  - 3. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 4. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
  - 4. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**END OF SECTION 262816**



## **SECTION 265100 - INTERIOR LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Included in the work of this section are labor, material, and appurtenances required to complete the work of this Section as specified herein, including, but not limited to:
  - 1. Interior light fixtures, lamps, LEDs, reflectors, lenses or faceplates, ballasts, transformers, drivers and power supplies (includes exterior light fixtures normally installed on exterior surfaces of buildings).
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Light fixture supports.
  - 5. Coordination.
  - 6. Quality assurances.
  - 7. Specific requirements.

#### **1.2 SUBMITTALS**

- A. General:
  - 1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.
  - 2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
  - 3. Prepare portfolios from manufacturer's standard specification sheets, and include the fixture tag indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.
  - 4. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
  - 5. Modifications to fixtures shall be in accordance with Architect's comments.
- B. Product Data: For each type of light fixture, collated and bound in sets, and arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  - 1. Summary page with the following for each light fixture type
    - a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
    - b. Light fixture ballast, driver or auxiliary device manufacturer, number and type.
  - 2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.
    - a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, fixture efficacy and/or efficiency, and verification of indicated parameters.
    - b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
  - 3. Light fixture mounting details, including non-standard outlet boxes.
  - 4. Construction of light fixture housing and door (if applicable).
  - 5. Ballast cut sheet with options marked, providing physical description of ballast including, but not limited to, voltage, lamp, ballast factor, power factor, amperage and wattage.
  - 6. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.
  - 7. Light fixture finish and color (if applicable).
  - 8. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the light fixture as applied in this Project.
    - a. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

9. Emergency ballast cut sheet: Descriptive cut sheets providing physical description of emergency ballasts for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.
- C. Shop Drawings: Show details of non-standard or custom light fixtures. Indicate dimensions, finish color, including, but not limited to, custom color, weights, methods of field assembly, components, features, accessories, and modifications. Scaled documents shall be provided for custom fixtures.
  - D. Submittal Schedule
    1. Within 30 days of Division 26 contractor award, shop drawings covering all light fixtures within this section shall be forwarded to architect to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.
    2. Within 15 days of "approved" and "approved as noted" shop drawings, contractor shall forward to Architect a guaranteed ship date for each specified fixture.
    3. Within 15 days after contractor's receipt of "reject and resubmit" or "not approved" shop drawings, contractor shall provide Architect with resubmitted shop drawings for only those fixtures deemed unacceptable.
    4. Contractor is responsible to call to the attention of the Architect any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures or as otherwise affecting Section 1.4.D of this specification.
  - E. Control Wiring
  - F. Field quality-control test reports.
  - G. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation and maintenance manuals.
  - H. Warranties: Special warranties specified in this Section.

### 1.3 SUBSTITUTIONS

- A. Refer to Division 26 Section "General Electrical Requirements".
- B. Prior to the Bid Date, substitutions will not be considered unless the Architect/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and complete Product Data for the proposed substitute, as defined in SUBMITTALS above, and all other information necessary for an evaluation. Provide interior point-by-point photometric calculations, under both normal and emergency lighting conditions, as applicable, if required by the Engineer. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.
- C. During the Bid
  1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.
  2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:
    - a. Agents can group only specified fixtures they represent, and
    - b. Only represent in the region where the specification originated, and
    - c. Exclude all fixtures outside their represented lines from the MLP, and
    - d. Sole-sourced (proprietary) light fixtures shall not be included in the MLP.
  3. Packaging of light fixtures will not be considered nor approved. Packaging is defined as: distributor(s) providing a single price for a light fixture package made up of specified and non-specified light fixtures. Any submittal package containing non-specified light fixtures or inclusion of lighting control systems will be immediately rejected in its entirety.
- D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Architect/Engineer.

- E. During the construction period, no substitutions shall be considered if product delay is due to contractor's failure to order products in a timely manner after presentation of fixture schedules and specifications. Additional costs associated with air freight or special factory runs to meet schedule due to contractor's error shall be at the expense of contractor.
- F. The Architect/Engineer has the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

#### 1.4 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature
- C. CFL: Compact Fluorescent
- D. CRI: Color-rendering index.
- E. CU: Coefficient of utilization.
- F. EISA: Energy Independence and Security Act of 2007.
- G. HID: High-intensity discharge.
- H. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs
- I. LED: Light Emitting Diode
- J. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.
- K. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.
- L. LER: Light fixture (Luminaire) efficiency rating.
- M. Light Fixture: Complete light fixture, including ballast housing if provided.
- N. RCR: Room cavity ratio.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
  - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 2. Marked for intended use.
- B. Comply with NFPA 70.
- C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- D. Regulatory Agencies: Provide fixtures conforming to nationally- or internationally-recognized accredited testing agencies, such as U.S., ETL, ARL, or others in acceptance with local code enforcement policy.
- E. Electrical Components and Devices: Provide only fixtures that comply with National Electric Code (NEC), and in particular to Section 410. All ceiling recessed fixtures, whether indicated in a catalog number or not, shall be equipped with an integral thermal protection device.

## 1.6 COORDINATION

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.
- B. Coordinate layout and installation of light fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including, but not limited to, HVAC equipment, fire-suppression system, and partition assemblies. Contractor shall arrange his installation in proper relation to other work so that there shall be no interference, damage or delay to other trades' work
- C. Give ample notice of any special openings or rough-in work required for placing electrical/lighting work so as to avoid cutting or removal of completed work.
- D. Where work of this Section is to be flush or concealed, install it so it does not project beyond finished lines of walls, ceilings or floor surface.
- E. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

## 1.7 WARRANTY

- A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.10.A.1. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.
- B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.
- C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.
  - 1. LED Luminaires, including LED modules, arrays and drivers: Five years.
  - 2. LED Lamps: Three years.
- D. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Emergency Lighting Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining coverage years.
  - 2. Warranty Period for Emergency Ballast and Self-Powered Exit Sign Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining coverage years.

## 1.8 SPARES

- A. Furnish spare materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Battery and Charger Data: One for each emergency lighting unit.
  - 3. Ballasts and/or Drivers: 2 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.



## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 MANUFACTURERS**

- A. In Light Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
  - 1. Basis-of-Design Product: The design for each light fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified that meets or exceeds performance characteristics of the named product.
  - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### **2.2 LIGHT FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS**

- A. Provide light fixtures as shown on the drawings and/or specified. This shall include all lamps, material and labor to securely hang light fixtures, clean them and make them completely ready for use. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures. Provide additional tie wires connected to structure to conform to applicable seismic requirements where required.
- B. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.
- C. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures. Manufacturer of recessed fixtures shall provide mounting brackets suitable for connection to ceiling system structure. Modifications to standard mounting brackets shall be coordinated with contractor and delivered with fixture so that no delays to product delivery shall be allowed.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
  - 4. Laminated Silver Metallized Film: 90 percent.
- H. Plastic Diffusers, Covers, and Globes:
  - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
    - b. UV stabilized.
  - 2. Glass: Annealed crystal glass, unless otherwise indicated.
- I. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
- J. Fixture Finishes:
  - 1. For corrosive or salt water environments, manufacturer shall provide fixtures with low copper/zinc cast aluminum (AB-47100 aluminum with less than 0.6% copper – classified for corrosive areas) housings to prevent salts from "pitting" aluminum housing. Manufacturer shall provide, in addition to or in lieu of, AB-47100 aluminum, ion added or pre-anodized polyester powder cast finish for "marine grade" applications. Manufacturer shall otherwise provide all stainless steel housing in conjunction with stainless steel hardware.

2. Recessed downlights in corrosive or salt water interior environments shall be equipped with a "natatorium" finish comprised of a zinc-chromated and phosphated process, then powder-coated on the exterior of the housing.
- K. Reflectors:
1. Provide aluminum reflectors or reflecting cones for downlight style fixtures comprised of #12 aluminum reflector sheet, 0.57 inch (15 gauge) or heavier and free of tool-making indentations, including spinning lines caused by assembly techniques. All reflectors shall be of first-quality, anodized finish :Alzak" with specular or semi-specular finish and color as selected. Provide specular reflectors with no apparent brightness above 45 degrees from Nadir and semi-specular, diffuse reflectors with no apparent brightness above 75 degrees from Nadir.
- L. Mounting hardware and trims:
1. Coordinate as need to suit ceiling conditions.
  2. Light fixtures near or in contact with insulation shall comply with code.
  3. Maintain a 3" minimum working clearance between non-IC rated light future housings and insulation on all adjacent ductwork, piping, walls and ceilings.
- M. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, ballasts and/or drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp, LEDs, ballast and/or driver characteristics:
    - a. "USE ONLY" and include specific lamp or LED type.
    - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires. Indicate maximum allowed wattage.
    - d. LED type, wattage, beam angle (if applicable) for LED luminaires. Indicate maximum allowed wattage.
    - e. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
    - f. ANSI ballast type (M98, M57, etc.) for HID luminaires.
    - g. CCT and CRI for all luminaires.
- N. Emergency lights and exit signs with integral battery back-up shall be connected to a separate unswitched conductor bypassing all other controls and contactors. Exit signs shall not be switched. Allow battery to charge for a minimum of 48 hours before light level testing. In order to prevent battery damage, do not turn off power for extended periods of time after the emergency light has been powered.

## 2.3 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
  2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

## 2.4 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

## 2.5 DRIVERS FOR LED LUMINAIRES

- A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:
  1. Sound Rating: A.
  2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
  3. Transient Voltage Protection: IEEE C62.41, Category A or better.
  4. Power Factor: 0.90 or higher at full load.
  5. Driver shall operate with maximum sustained variations of +/-10% input voltage and frequency with no damage to driver.
  6. Driver output shall be regulated to maximum +/- 5% published load range or requirements of downstream LED fixture.
  7. LED Current Crest Factor: 1.5 or less.
  8. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
  9. Meets EN610000 for input harmonics.
  10. ROHS Compliant.
- B. Dimming Drivers:
  1. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
    - a. Luminaires: 100 to 10 percent of rated lumens.
  2. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
  3. Compatibility: Certified by manufacturer for use with specific dimming control system and LED indicated.
  4. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

## 2.6 LED LAMPS AND LUMINAIRES

- A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 80 CRI minimum and 3500K CCT.
- B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values or as indicated in the Light Fixture Schedule, whichever is more stringent. All LEDs used for same fixture type throughout the project to originate from same production bin.
- C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% maintained initial-rated lumens at average rated life of as follows:
  1. LED lamps: 20,000 hours
  2. LED luminaires: 50,000 hours
- D. ROHS compliant
- E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Cree, Nichia, Osram or Xicato LEDs; additional manufacturers may be considered however the Architect or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

## 2.7 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

- A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system. Where equipment is not indicated as plenum rated, provide an additional enclosure for the device(s) suitable for the installed environment.

## 2.8 LIGHT FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## 2.9 TRANSFORMERS FOR LOW VOLTAGE FIXTURES

- A. Provide transformers to low voltage lamps which are suitable for the electrical characteristics of the supply circuits to which they are to be connected. For remote electronic or magnetic transformers, contractor shall remote transformers so as to reduce voltage drop. For 25 amp low-voltage linear systems, contractor shall not daisy-chain 25A loaded runs together. Contractor shall provide home-run from end of run to remote transformer.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Light Fixtures: All work shall be executed to present a neat appearance. Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- C. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- D. Support for Light Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
  - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from light fixture corners.
  - 2. Support Clips: Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- E. Suspended Light Fixture Support:
  - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Provide suitable connectors or collars to connect adjoining units to appear as a continuous unit.
4. Decorative pendant mounted light fixtures
  - a. Provide cord and/or stem lengths to match elevations above finished floor as indicated on architectural elevations. If architectural elevations do not indicate suspension heights, coordinate with Architect to determine final suspension heights. Regardless, contractor shall not field cut pendants or order rigid stems without elevation approval from Architect. Pendant suspensions on electrical documents are for reference only.
    - 1) Cord-mounted: Manufacturers shall supply luminaires with flexible, field cutting cords. Contractor shall field cut cords as required.
    - 2) Field-cutable, rigid-stem mounted: Manufacturers shall supply luminaires with field cutting rigid stems. Contractor shall field cut stems as required.
    - 3) Factory-cut rigid stem mounted: Contractor shall provide rigid stem dimensions to the manufacturer as required.
  - b. Junction boxes used to feed light fixtures shall be covered by manufacturer supplied canopy plates.
- F. Installation within non-standard ceilings, including, but not limited to, wood and metal ceilings.
  1. For recessed downlight light fixtures, specification is based on standard throats to accommodate ceiling thicknesses of  $\frac{3}{4}$ " or less. If non-standard ceiling (such as wood, thickened gypsum board ceilings and metal plank type) require throats greater than  $\frac{3}{4}$ ", modifications to manufacturer's standard  $\frac{3}{4}$ " throat shall be determined by Architect and Contractor prior to shop drawing submission.
  2. For light fixtures recessed into metal ceilings, rigidly support light fixture to ensure that trim fits flush with ceiling plane.
- G. Manufacturer shall supply contractor with a complete list of component elements to comply with design intent for either 20-amp (flexible low voltage track systems or line voltage track) or 50-amp bus bar track systems. Contractor shall install track systems based on design requirements outlined herein or Light Fixture Schedule.
- H. Connect wiring according to Section "260519 - Low-Voltage Electrical Power Conductors and Cables."
- I. Through wiring of recessed light fixtures, in suspended ceilings, is not permitted. Connect each light fixture by a whip to a junction box. The whip shall be of sufficient length to allow the light fixture to be relocated within a 6-foot radius.
- J. Wall Mounted Light fixtures
  1. Unless otherwise noted, conceal all raceways and back boxes for wall mounted light fixtures. Coordinate all wall-mounted light fixtures with interior elevations. Where specific elevations or dimensions are not indicated, verify the correct location with Architect prior to installation. Contractor shall supply structure to support weight of fixture.
- K. Contractor shall construct light coves according to architectural details. Contractor shall ensure, unless otherwise directed, that top of fixture lamp is flush with top of cove lip. Contractor shall provide blocking as needed under fixture to ensure stated requirement.
- L. Auxiliary Devices for low voltage and LED Fixtures
  1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
  2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.
  3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
  4. Properly support remote lighting devices, including transformers, power supplies, and drivers, per Code and manufacturer's recommendations.

### 3.3 DIMMING

- A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:
  1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
- B. Coordinate light fixture and control device dimming types for compatibility.

### 3.4 COORDINATION

- A. Light fixtures shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings for exact locations.
- B. Coordinate the installation and location of light fixtures with other work and all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.
- C. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.
- D. Coordinate final light fixture locations in walk-in coolers and freezers with refrigeration coils and other trades.
- E. Wall-Mounted Light fixtures
  - 1. Coordinate all wall-mounted light fixtures with the architectural features of the building. Where specific elevations or dimensions are not indicated, verify the correct location with the Architect prior to beginning any work.

### 3.5 ADJUSTING

- A. Contractor shall adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Architect.

### 3.6 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- C. Upon completion of the installation of light fixtures, and after building circuits have been energized, energize lighting branch circuits to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. At the time of final acceptance of this project by the Owner, ensure that all lamps are in working order and all light fixtures are fully lamped.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

### END OF SECTION 265100

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## **SECTION 270010 - GENERAL COMMUNICATIONS REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED SECTIONS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and to all following sections within Division 27.

#### **1.2 SECTION INCLUDES**

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, 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, supplies, tools, equipment, transportation and utilities.
- B. Division 27 of these Specifications, and Drawings numbered with prefix TN, generally describe these systems, but the scope of the Communications Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

#### **1.3 ABBREVIATIONS AND ACRONYMS**

- A. ADA Americans with Disabilities Act
- B. AFF Above Finished Floor
- C. AHJ Authority Having Jurisdiction
- D. ANSI American National Standards Institute
- E. ASTM American Society for Testing and Materials
- F. BICS Building Industry Consulting Service International
- G. ETL Electrical Testing Laboratories, Inc.
- H. FCC Federal Communications Commission
- I. FM Factory Mutual
- J. GE Grounding Equalizer
- K. IEEE Institute of Electrical and Electronic Engineers
- L. LED Light Emitting Diode

M.	NEC	National Electrical Code
N.	NESC	National Electrical Safety Code
O.	NEMA	National Electrical Manufacturers Association
P.	NFPA	National Fire Protection Association
Q.	NRTL	Nationally Recognized Testing Laboratory
R.	OEM	Original Equipment Manufacturer
S.	OFCI	Owner Furnished Contractor Installed
T.	OSHA	Occupational Safety and Health Administration
U.	OSP	Outside Plant
V.	RCDD	Registered Communications Distribution Designer
W.	TBB	Telecommunications Bonding Backbone
X.	TGB	Telecommunications Grounding Bus-bar
Y.	TIA	Telecommunications Industries Association
Z.	TMGB	Telecommunications Main Grounding Bus-bar
AA.	UL	Underwriters Laboratories
BB.	UON or UNO	Unless Otherwise Noted

#### 1.4 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
  2. Approved Equivalents or Equal - For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.
  3. As Directed - means as directed by the Contract Administrator, or his representative.
  4. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, cable terminations, and cross-connect wiring, as well as those for audio video systems and potentially other low-voltage systems such as security and fire alarm (electronic safety and security). This room is recognized in ANSI/TIA-569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities.
  5. Concealed - means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
  6. Conditionally Approved – the manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
  7. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is the Architect.
  8. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Contract Administrator, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Design Professional, in addition to involvement by, and obligations to, the "Contract Administrator".
  9. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."

10. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.
11. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
12. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.
13. Provide - "To furnish and install complete, and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
14. Submit - means submit to Contract Administrator for review.
15. Substitution - means a product meeting all requirements and specifications and having been approved by the Design Consultant to replace another product specifically identified herein.
16. Wet Location - means a pathway that does not protect cables from moisture levels that are beyond the intended operating range of "inside" premises cable.
  - a. For example: Slab-on-grade construction where pathways are installed underground or in concrete slabs that are in direct contact with soil (e.g., sand and gravel) is considered a "wet location."
  - b. Also refer to the:
    - 1) Telecommunications Distribution Methods Manual (TDMM) for definitions of Wet locations
17. (\*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Design Consultant as equivalent to the item or manufacturer specified".

C. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

## 1.5 REFERENCE STANDARDS

- A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them.
- E. The references to the following codes, references and standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the latest revision or printing (UON):
  1. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
  2. NFPA 70 – National Electrical Code (NEC)

3. IEEE National Electrical Safety Code (NESC)
4. Americans with Disabilities Act (ADA) of 1990, as amended

## 1.6 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other Divisions for Communications work to be included but not listed in Division 27 or indicated on Communications Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.
- C. Refer to Communications Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide all offsets, fittings, and accessories, required to clear equipment, beams and other structural members which may be required but not shown on the Drawings.
- D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Communications systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.
- F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
- G. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.
- I. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades, and report any discrepancies between them to the Contract Administrator and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- J. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.
- K. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Contract Administrator.
- L. Measurements and Layouts: The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

## 1.7 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
  2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
  3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
  4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
  5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
  6. Indicate required installation sequence to minimize conflicts between entities.
  7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
  8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of communications equipment locations within communications (telecom and AV) rooms, electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
  2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
  3. Indicate path to allow the future removal of each large piece of equipment (including but not limited to communications racks and cabinets) without removal of nonrelated equipment or architectural elements.
  4. Include work provided by others routed through the equipment rooms.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
  2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
    - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
  3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
  4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.
- D. Refer to Coordination requirements in specific sections for additional information.

## 1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Design Consultant that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Design Consultant's designated representatives. Contractor shall allow for the Design Consultant Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

- D. Design Consultant Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Design Consultant review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct phases:
  - 1. Pre-bid
    - a. Required no less than two weeks prior to the due date for the submission of bids, such as:
      - 1) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
      - 2) Alternate personnel credentials to be reviewed for approval
      - 3) And as required by individual sections in this Division
  - 2. Bid
    - a. Required at the time of the submission of bids, such as:
      - 1) Bid Response Forms
      - 2) Unit Pricing (if required by sections in this Division)
      - 3) Personnel Qualifications
      - 4) Contractor Qualifications (Previous project references)
      - 5) Voluntary Bid Alternates
      - 6) And as required by individual sections in this Division
  - 3. Pre-construction
    - a. Required after the award of the project to the winning bidder and prior to starting construction.
    - b. Submit the following items no longer than four weeks after receiving the notice to proceed:
      - 1) Division of Labor amongst sub-contractors. Include:
        - a) Company Name
        - b) Address
        - c) Name of project manager for this project, including:
          - i) E-mail
          - ii) Telephone number
      - 2) Construction schedule showing important milestone dates and activities. Schedule shall be coordinated with overall project construction schedule.
      - 3) Updated Personnel and Contractor Qualifications where different from those submitted during the Bid phase.
      - 4) A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.
      - 5) Manufacturers' cut-sheets:
        - a) Cut-sheets are to be in the same order as in the specification sections.
        - b) At a minimum all cut-sheets shall contain the following:
          - i) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
          - ii) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo somewhere on the page
          - iii) All parts, pieces, and equipment submitted for review shall be clearly identified by stamp, markup, or highlight in such a manner that the product(s) being submitted are clearly identifiable and distinguished from all other materials, parts, or equipment that may be on the submittal.
          - iv) For cut-sheets with accessories, additional parts, or derivations of the product being submitted, all shall be clearly identified for the reviewer and acceptance.

- v) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
  - 6) Samples – refer to individual sections for specific sample requirements.
    - a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer shall cover all associated fabrication and shipping costs.
  - c. Submit the following items sufficiently prior to installation of each respective portion of work:
    - 1) Shop Drawings
      - a) Shall be furnished per the requirements of each Division 27 specification Section.
- 4. Project Completion
  - a. Required after the substantial completion but prior to final approval for completion, such as:
    - 1) Record Drawings
    - 2) Operation and Maintenance Data
    - 3) Project test reports
    - 4) Cable Databases (as applicable)
    - 5) Warranty Certificate(s)
    - 6) Lead Installer / Project manager letter with signature stating the project has been installed in accordance with referenced industry standards and contract documents.
    - 7) And as required by individual sections in this Division
- I. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- J. Refer to individual Sections for additional submittal requirements.
- K. No part of the work shall be started in the shop or in the field until the shop drawings and /or samples for that portion of the work have been submitted and accepted.
- L. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- M. Submittals shall contain the following information:
  - 1. The project name.
  - 2. The applicable specification section and paragraph.
  - 3. Equipment identification acronym as used on the drawings.
  - 4. The submittal date.
  - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
  - 6. Submittals not so identified will be returned to the Contractor without action.
- N. The checking and subsequent acceptance by the Design Consultant and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Design Consultant and Contract Administrator prior to implementing any deviation.

#### 1.9 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Contract Administrator, and Owner the following:
  - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
  - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
  - c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
  - d. Same warranty will be furnished for proposed substitution as for specified Work.
  - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
  - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

#### 1.10 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.
- C. Contact the Contract Administrator for written authorization.
- D. The following must be received before electronic drawing files will be sent:
  1. Contract Administrator's written authorization
  2. Engineer's release agreement form
  3. Payment

#### 1.11 QUALITY ASSURANCE

- A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.
- B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.



#### 1.12 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.
- F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

#### 1.13 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division.

#### 1.14 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

#### 1.15 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

- D. Be responsible for the safe storage of tools, material and equipment.

#### 1.16 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.
- D. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- E. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- F. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

#### 1.17 TEMPORARY FACILITIES

- A. Refer to Division 1 and General Conditions for Temporary Facilities requirements.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

#### 1.18 FIELD CONDITIONS

- A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:
  - 1. The Drawings describe the general nature of remodeling to the existing building; however, visit the Site prior to submitting bid to determine the nature and extent of work involved.
  - 2. Schedule Work in the existing building with the Owner.
  - 3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves Communications systems, equipment, raceways, equipment supports or foundations and materials.
  - 4. Remove articles that are not required for the new Work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
  - 5. Relocate and reconnect Communications facilities that shall be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where communications equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
  - 6. Obtain permission from the Contract Administrator for channeling of floors or walls not specifically noted on the Drawings.
  - 7. Protect adjacent materials indicated to remain. For Work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
  - 8. Locate, identify, and protect Communications services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services shall be interrupted, provide temporary services for affected areas.
- B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- C. Use of explosives is not permitted.

- D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

## **PART 2 - PRODUCTS**

### 2.1 NOT USED

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION, GENERAL

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

### 3.2 EXISTING CONDITIONS

- A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.
- B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

### 3.3 EXISTING UTILITIES

- A. Existing utility services not specifically indicated to be removed or altered shall remain as they presently exist.
- B. Where existing services interfere with demolition or construction, alter or reroute such existing equipment to facilitate demolition or construction after obtaining written permission from the Contract Administrator. Notify in writing giving two weeks advance notice or planned alteration prior to altering any existing condition is required.
- C. Schedule and coordinate with the utility company, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal services from any existing service provider line. Include all premium time required for all such work in the Bid.
- D. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.
- E. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or Utility Company without additional cost.
- F. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.
- G. Make repairs and restoration of utilities before workmen leave the project at the end of the workday in which the interruption takes place.
- H. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

### 3.4 EXAMINATION OF SITE

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical, electrical, communications, and Electronic Safety and Security installations, above or below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other

information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

### 3.5 WORK IN EXISTING FACILITIES

- A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of Work involved.
- B. Schedule Work in the existing facility with the Owner.
- C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves communications systems, conduit, wiring, equipment, equipment supports or foundations and materials.
- D. Remove all of these articles that are not required for the new Work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.
- E. Interruption of Existing Communications Service: Do not interrupt communication service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary communication service according to requirements indicated:
  - 1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of communication service.
  - 2. Do not proceed with interruption of communication service without Contract Administrator and the Owner's written permission.
  - 3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
- F. Reconnect communication circuits serving equipment required to remain in service to other cable termination fields, patch panels or splices as indicated on the Drawings or as appropriate. Provide additional cable and termination hardware where there is insufficient available capacity in remaining existing equipment for reconnection.
- G. Relocate and reconnect all communications facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where communications devices or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.
- H. Finish materials are specified in other divisions.
- I. Where removal of existing wiring interrupts continuity of communication circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued communication continuity.
- J. Channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all channeling not specifically noted on the Drawings.

### 3.6 PERMITS AND FEES

- A. Secure and Pay all required fees and obtain all required permits related to the Communications Infrastructure installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.

### 3.7 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements.
- B. General: Demolish, remove, demount, and disconnect abandoned communications materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment to Be Salvaged:

1. Communications Infrastructure equipment to be removed that is in good working order shall be carefully removed and offered to the Owner. Items rejected by the Owner shall be removed from the project site and legally and properly disposed of.
  2. Remove, demount, and disconnect existing communications materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Remove existing conduit and wire back to the Communications Equipment room, unless a specific extent of removal is indicated on the Drawings.
- E. Communications Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
    - a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
    - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 27.

### 3.8 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

### 3.9 PENETRATIONS

- A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 27 Section "Common Work Results for Communications".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and cable trays that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

### 3.10 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

### 3.11 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.

- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

### 3.12 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.
- C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- D. Touch up and restore damaged finishes to their original condition.
- E. All communications equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation as required.

### 3.13 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all equipment furnished and/or installed under this Division.
- B. Check and test protective devices for specified and required application, and adjust as required.
- C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- D. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- E. Refer to individual Sections for additional and specific requirements.

### 3.14 START-UP OF SYSTEMS

- A. Prior to start-up of each system, check all components and devices to confirm compliance with manufacturers' recommended installation procedures.
- B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- C. Refer to individual Sections for additional and specific requirements.

### 3.15 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
  1. Submit results of systems tests and adjustments per each individual section.
  2. Submit complete Operation and Maintenance Data.
  3. Submit complete Record Drawings.
  4. Perform all required training of Owner's personnel.

5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
  6. Perform start-up tests of all systems.
  7. Remove all temporary facilities from the site.
  8. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.
- B. Request in writing a review for Substantial Completion and scheduling of final acceptance. Provide a minimum of five (5) business days notice prior to the review for project sites within a 4-hour drive from the office where the design was created; provide a minimum of eight (8) business days notice for sites beyond a 4-hour drive.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Contract Administrator and Design Consultant for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

#### 3.16 EARLY OCCUPANCY

- A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.
1. Refer to individual sections for additional requirements.
- B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

#### END OF SECTION 270010

## SUBSTITUTION REQUEST FORM

To Project Engineer: \_\_\_\_\_ Request # (GC Determined): \_\_\_\_\_

Project Name: \_\_\_\_\_

Project No/Phase: \_\_\_\_\_ Date: \_\_\_\_\_

Specification Title: \_\_\_\_\_

Section Number: \_\_\_\_\_ Page: \_\_\_\_\_ Article/Paragraph: \_\_\_\_\_

Proposed Substitution: \_\_\_\_\_

Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_

Address: \_\_\_\_\_ Phone: \_\_\_\_\_

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: \_\_\_\_\_

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples  
☐ Tests ☐ Reports ☐ Other: \_\_\_\_\_

Reason for not providing specified item: \_\_\_\_\_

Similar Installation:

Project: \_\_\_\_\_ Architect: \_\_\_\_\_

Address: \_\_\_\_\_ Owner: \_\_\_\_\_

Date Installed: \_\_\_\_\_

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: \_\_\_\_\_



**Substitution Certification Statement:**

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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**Manufacturer's Certification of Equal Quality:**

I \_\_\_\_\_ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
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**Engineer Review and Recommendation Section**

Recommend Acceptance      ☐ Yes      ☐ No

Additional Comments:      ☐ Attached      ☐ None

**Acceptance Section:**

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

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## **SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SECTION INCLUDES**

- A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements for Division 27 systems as follows:
  - 1. Grounding and Bonding for Communications
  - 2. Pathways for communications systems.
    - a. Cable Supports
    - b. Conduit
    - c. Surface Raceways
    - d. Outlet Boxes
    - e. Pull Boxes
  - 3. Firestopping Systems
  - 4. Identification

#### **1.2 RELATED REQUIREMENTS**

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in the following Sections: 27 Section "General Communications Requirements"
- B. Division 07 Section "Penetration Firestopping" for fire stopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
- C. Division 26 for reference regarding materials and methods for additional requirements.
- D. Division 27 Section "General Communications Requirements"

#### **1.3 DEFINITIONS**

- A. ASTM - American Society for Testing and Materials
- B. AV – Audio Video
- C. Cable Tray System – A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.
- D. Common Work – all Work specified in this section.
- E. Conduit Body – A separate portion of a conduit or tubing system that provides access through a removeable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.
- F. Conveniently Accessible – Capable of being reached from the floor or via the use of an 8 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.
- G. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.
- H. Floor Box Assembly (Floor Box) – An on-grade solution or above grade (with a native fire classification or in combination with an approved Firestopping System) solution for in-floor terminations. The Assembly consists of pour pan (as applicable), Firestopping System (as applicable), floor box (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates), and access door / cover / lid.
- I. FM – Factory Mutual

- J. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- K. IMC – Intermediate Metal Conduit
- L. NEMA – National Electrical Manufacturers Association
- M. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
- N. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.
- O. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn't identified on the drawings, assume the Main Communications (MDF) also acts as the Point of Entrance.
- P. Poke Through Assembly (Poke-Thru) – An above grade solution with a native fire classification for in-floor terminations. The Assembly consists of pre-pour sleeve (as applicable), Firestopping System, fire resistant conduit stub, poke thru (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates, as applicable), and access door / cover / lid.
- Q. Quality Control Specialist – as it pertains to Work within this section, Quality Control Specialist is either the Project RCDD, as defined in Division 27 Section "Structured Cabling System", for Common Work for Telecommunications or the Project AVIXA CTS-I.
- R. RMC – Rigid Metal Conduit
- S. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- T. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- U. UL – Underwriters Laboratory

#### 1.4 REFERENCE STANDARDS

- A. Follow all applicable codes, references, guidelines, and standards listed in Division 27 Section "General Communications Requirements".
- B. Follow the additional codes, references, standards and guidelines:
  - 1. NEMA VE 1-2017 – "Metallic Cable Tray Systems"
  - 2. NEMA VE 2-2013 with 2016 Corrections – "Cable Tray Installation Guidelines"
  - 3. ASTM E 814 and ANSI/UL1479 – "Fire Tests Through Penetration Firestops"
  - 4. ASTM E 84 and ANSI/UL 723 "Surface Burning Characteristics of Building Materials"
  - 5. ASTM E 119 and ANSI/UL 263 "Fire Tests of Building Construction Materials"

#### 1.5 ADMINISTRATIVE REQUIREMENTS

- A. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication:
  - 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
  - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
  - 3. So connecting raceways, cables, and wireways 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 communications items that are behind finished surfaces or otherwise concealed.

## 1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements".
  - B. Bid Submittal
    - 1. Contractor Qualifications for Firestopping Systems: Provide copies of training/certification as required in the Quality Assurance portion of this specification section.
  - C. Pre-construction Submittal
    - 1. Manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:
      - a. In addition to Division 27 Section "General Communications Requirements", include the following:
        - 1) Size – including physical and loading dimensions
        - 2) Maximum span length
        - 3) Weight supported
        - 4) Type
        - 5) Fittings to be used
        - 6) Method of attachment to structure
        - 7) Firestop system assembly information for each system to be installed:
          - a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
            - i) Firestop manufacturer
            - ii) UL system number
            - iii) F, T, and L Ratings
            - iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.
        - 8) As well as any additional information required by individual sections of this Division
    - 2. Shop Drawings
      - a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.
        - 1) Each pathway shall be identified by type and size on the drawings.
          - a) Example #1: 4" EMT
          - b) Example #2: 4" x 12" Cable Tray
        - 2) Each grounding conductor shall be identified by size (and insulation):
          - a) Example: #3/0 insulated ground
        - 3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.
          - a) Example #1 – Firestopping Sleeve: EZ-Path Series 22, UL System W-L-3255
          - b) Example #2 – Backbox in Fire-Rated Wall: Specseal Power Shield, UL System QCSN/CLIV.R14288
        - 4) Each pullbox and access panel shall be identified by size and height above finished floor.
          - a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.
      - b. Unless otherwise required by these specifications, it is permissible to show pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop drawing along with the cabling and system work to be installed through those pathways.
        - 1) Division 271000 "Structured Cabling System" and Division 274100 "Audio Video Systems" and their individual pathways shall be separate shop drawings; shared pathways such as cable tray shall be shown on both shop drawings.
- D. Project Completion Submittal
  - 1. Record Drawings:

- a. The Quality Control Specialist shall review the installation and Record Drawings for the Common Work Results required for their scope of work and shall stamp the final Record Drawings with their RCDD or CTS-I stamp before submission. By stamping the Record Drawings, the Quality Control Specialist indicates that the Common Work Results have been installed per the Contract Documents and all associated codes, standards, and guidelines, and all changes to the drawings have been incorporated into the Record Drawings.

## 1.7 QUALITY ASSURANCE

- A. Submittals and Shop Drawings for all Common Work Results specified in this section shall, if not created by, be reviewed by the Quality Control Specialist.
  1. The Quality Control Specialist shall stamp all relevant submittals for their associated Division 27 sections, which indicates that at a minimum the proposed work has been reviewed by them and found to be in compliance in regards to:
    - a. All applicable codes and industry standards and guidelines referenced in Division 27.
    - b. Being fully-coordinated with all other trades and to be installed per the Construction Documents.
    - c. And installed per manufacturer's direction.
- B. The Quality Control Specialist shall also make weekly inspections during construction to ensure all work installed per this section is correct.
  1. Any deficiencies encountered prior to and during installation shall be corrected by the installing contractor under the direction of the Quality Control Specialist and/or the Design Consultant.
- C. Firestopping Systems
  1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
  2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:
    - a. FM Research, approved in accordance with FM AS 4991.
    - b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

## 1.8 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The list below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants or sleeves.
  1. Offices
  2. Conference Rooms

## **PART 2 - PARTS AND MATERIALS**

### 2.1 GROUNDING AND BONDING FOR COMMUNICATIONS

- A. Refer to drawings and Division 27 Sections "Telecommunications Equipment Room Fittings" for exact grounding and bonding requirements.

### 2.2 PATHWAYS FOR COMMUNICATIONS SYSTEMS

- A. General
  1. All non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable
  2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
  3. Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.
- B. Cable Supports
  1. The following manufacturers are Conditionally Approved.
    - a. Cooper/B-Line
    - b. Hilti
    - c. Monosystems

- d. nVent Caddy
- e. Panduit
- f. Snake Tray
- g. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
- 2. Metal Hook Supports (“J-hooks”)
  - a. Specifications
    - 1) Have a flat bottom and sufficient width to comply with the minimum bend radius of all cabling as required by the referenced standards and manufacturers recommendations.
    - 2) Be open for easy lay-in and removal of cabling
    - 3) Be designed so the mounting hardware is recessed to prevent cable damage
    - 4) 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
    - 5) Cable hooks for corrosive areas shall be stainless steel, AISI Type 304
    - 6) Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions
    - 7) Be factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed
  - b. Cable hooks for installation above ceilings shall be
    - 1) B-Line series BCH21, BCH32, BCH64
    - 2) Caddy CABLE-CAT 21 or 32 series hangers
    - 3) Or equivalent from Conditionally Approved manufacturer
- 3. Fabric Saddle Supports
  - a. Specifications
    - 1) Suitable for air handling spaces (plenum)
    - 2) Adjustable strap allows for multiple support sizes to reduce inventory.
  - b. Cable supports for installation above ceilings shall be
    - 1) nVent CADDY CAT 425, 425A6
    - 2) Arlington Fittings TL20P, TL25P, TL50P

C. Conduit

- 1. Specifications
  - a. Refer to Electrical Division 26 for specific product and material information.
    - 1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
  - b. Conduits provided as connection to incoming services, utilities, including private services to other buildings or outside connection points shall be rigid metal or intermediate metal conduit at the point it enters the building, emerges from an exterior wall or ground floor slab to the final termination/transition point.
  - c. If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet (15.3 m) for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated. Generally this connection point will be a designated Entrance Room for Communications or the Main Telecommunication space. If space has not been identified the contractor shall request information prior to bid.
  - d. Provide conduit as indicated on the Drawings or required by this Specification. Minimum conduit size shall be 1 inch (25.4 mm) for structured cabling. Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as communications (Telecom), AV, TV, Broadcast, Intercom, etc.), at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.
  - e. Route an empty conduit from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, route conduits to the nearest accessible corridor ceiling or communications space.

<u>Number of Structured Cabling Outlets/Connectors</u>	<u>Conduit Size</u>
Up to 4	1 inch (25.4 mm)
Up to 9	1-1/4 inch (31.8 mm)

- D. Acoustical Pathway
1. Specifications
    - a. For use in non-rated walls only.
    - b. For use in place of conduit sleeves through walls of noise critical spaces.
    - c. Plenum Rated (to UL2043)
    - d. Sound Transmission Classification (STC) as tested per ASTM E90 shall be greater than 60.
  2. Manufacturer shall be:
    - a. Hilti CS-SL SA
    - b. Specified Technologies, Inc. - NEZ33
- E. Surface Raceways
1. The following manufacturers are Conditionally Approved.
    - a. Surface Metal Raceways
      - 1) Hubbell
      - 2) Legrand/Wiremold
      - 3) Mono-Systems Inc.
      - 4) Panduit
      - 5) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
    - b. Surface Nonmetallic Raceways
      - 1) Hubbell
      - 2) Legrand/Wiremold
      - 3) Mono-Systems Inc.
      - 4) Panduit
      - 5) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
  2. Specifications
    - a. Refer to Electrical Division 26 for specific product and material information.
      - 1) Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.
    - b. Raceways shall be sized per the quantity and size of the installed cables, plus 50% spare capacity. Minimum cross-sectional area shall be 1 inch.
    - c. Single gang and double gang surface boxes shall be a minimum of 2-1/2 inches deep.
    - d. Color shall be as directed by the Architect.
  3. Manufacturer shall be:
    - a. Submit product cutsheet(s) from Conditionally Approved manufacturer listed above.
- F. Outlet Boxes
1. Specifications
    - a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
    - b. Telecommunications – for outlets shown on TN series drawings:
      - 1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match that of wall gypsum board(s).
        - a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings); or
        - b) RANDL T-55017; or
        - c) Or equivalent from
          - i) Emerson/Appleton
          - ii) Thomas & Betts/Steel City
          - iii) Approved Substitution
      - 2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches (101.6 mm) width by 4 inches (101.6 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).
        - a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.
        - b) Or equivalent from
          - i) Emerson/Appleton
          - ii) Thomas & Betts/Steel City
          - iii) Approved Substitution



- 3) For 6" or 8" deep masonry walls: where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 3-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 3-1/2 inches deep.
  - a) Single gang – RACO 695
  - b) Double gang – RACO 696
- 4) Weatherproof: Aluminum die cast, weatherproof box with 1" conduit connection. Where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 2-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 2-1/2 inches deep.
  - a) Single gang – Thomas and Betts – IHD3-3 or equivalent
    - i) Or equivalent from
      - (1) Emerson/Appleton
      - (2) Hubbell/RACO
      - (3) Approved Substitution
  - b) Double gang – Thomas and Betts – 2IHD5-3 or equivalent
    - i) Or equivalent from
      - (1) Emerson/Appleton
      - (2) Hubbell/RACO
      - (3) Approved Substitution

G. Pull Boxes – for interior use only

1. Specifications
  - a. NEMA 1
  - b. Refer to Execution section for sizing requirements.
  - c. Shall be keyed
2. The following manufacturers are Conditionally Approved.
  - a. Hoffman
  - b. NEMA Enclosures
  - c. Wiegmann
  - d. Or Equivalent

H. Firestopping systems

1. General
  - a. All firestopping systems for Division 27 conduit, sleeves, cabling, boxes, etc. shall be from a single manufacturer, unless otherwise noted.
2. The following manufacturers are Conditionally Approved.
  - a. 3M
  - b. Hilti
  - c. Specified Technologies, Inc
3. Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.

I. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)

1. Specifications
  - a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
  - b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
  - c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
  - d. Allows the installation and removal of cables without the need to remove or add any materials.
  - e. Used to seal penetrations of cables through fire rated partitions
  - f. Not subject to the single manufacturer requirement
2. Manufacturer shall be:
  - a. EZ-Path family of products by Specified Technologies Inc.
  - b. Hilti Firestop Speed Sleeve CP 653 Series

J. Firestopping for Backboxes in Fire-Rated Walls

1. Specifications
  - a. Used to seal backboxes in fire rated partitions.

- b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
    - c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
  - 2. Manufacturer shall be:
    - a. Hilti CP 617 or CFS-P PA
    - b. Specified Technologies Inc., SpecSeal Power Shield
    - c. Or equivalent from Conditionally Approved manufacturer.
- K. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications
  - 1. For fire-rated penetrations where the conduit pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications not previously addressed in this specification.
  - 2. Specifications:
    - a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.
  - 3. Manufacturer shall be:
    - a. Hilti – submit UL System documentation for each floor/wall type and product cutsheets for all Hilti materials to be utilized
    - b. Specified Technologies Inc. – submit UL System documentation for each floor/wall type and product cutsheets for all STI materials to be utilized
    - c. Or equivalent from Conditionally Approved manufacturer.

## 2.3 IDENTIFICATION FOR COMMON WORK FOR COMMUNICATIONS SYSTEMS

- A. Labels
  - 1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.
    - a. Brady
    - b. Brother
    - c. Dymo
    - d. HellermannTyton
    - e. Panduit
    - f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
  - 2. Specifications:
    - a. Refer to additional requirements in Part 3 – Execution.
    - b. Refer to individual sections for additional identification requirements for specific work.

## 2.4 KEYS

- A. Supply two copies of every key as required for pullboxes and junction boxes.

## **PART 3 - EXECUTION**

### 3.1 PATHWAYS FOR COMMUNICATIONS

- A. General
  - 1. Refer to Electrical Division 26 for additional installation requirements.
    - a. Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.
  - 2. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
  - 3. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
  - 4. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
  - 5. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling when contractor performs conduit sizing calculations, otherwise follow conduit sizes indicated on drawings.
  - 6. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).

7. Store and keep dry all products in original container in a climate controlled environment until installation is to occur
8. Install all communications pathways:
  - a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
  - b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
  - c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
  - d. So that the maximum allowable pulling tension is not exceeded.
  - e. To meet the requirements of the structure and the requirements of all other Work on the Project
  - f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
  - g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
  - h. Parallel or perpendicular to building lines or column lines.
  - i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
9. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
  - a. Except when supported by ladder racking within each Telecommunications room, UON.
10. Provide adequate communications pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for communications cabling purposes. Any deviation from this will not be accepted.
  - a. At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports. UON
  - b. At no point shall cables come in contact with, be supported by, or attach to building structures or supports; UON
11. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).
12. Suspended cables shall be installed with at least 3 inches (76.2 mm) of clear vertical space above the ceiling tiles and support channels (T-bars).
13. Waterproofing
  - a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
  - b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.
14. Cutting and Patching
  - a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
  - b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
  - c. Patch around all openings to match adjacent construction.
  - d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
  - e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
  - f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.
15. Mounting Heights
  - a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.
    - 1) Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.

- b. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
  - c. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.
16. Painting
- a. Refer to Division 9 Section "Painting" for painting requirements.
  - b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
  - c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
  - d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
  - e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
  - f. Provide touch-up paint as required by Specification Sections in this Division.
17. Fastenings
- a. Fasten equipment to building structure in accordance with the best industry practice.
  - b. Where weight applied to the attachment points is 100 pounds or less, conform to the following as a minimum:
    - 1) Wood: Wood screws.
    - 2) Concrete and solid masonry: Bolts and expansion shields.
    - 3) Hollow construction: Toggle bolts.
    - 4) Solid metal: Machine screws in tapped holes or with welded studs.
    - 5) Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.
  - c. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:
    - 1) At concrete slabs provide 24 inch x 24 inch x ½ inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
    - 2) At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.
  - d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:
    - 1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
  - e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
  - f. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.
  - g. Bridle rings are prohibited for Division 27 cables, unless otherwise noted on drawings.
18. For large quantities of cables (greater than 50) that converge upon a common run such as at a rack, in corridors, and other areas, provide cable trays or other special supports that are specifically designed to support the required cable weight and volume.
19. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces. Install Acoustical Pathway(s) through walls of noise critical spaces

B. Access to pathways and associated equipment

- 1. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.
- 2. Provide an Access Panel where equipment or devices are located above inaccessible ceilings. Where access doors are necessary but not shown on the plans, coordination type and location with Architect and Design Consultant through an RFI.

- a. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
    - b. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.
  3. Maintain all code required clearances and clearances required by manufacturers.
- C. Cable distribution
  1. Provide pathways for Telecommunications (Structured Cabling System) to allow cabling to be installed in the following manner:
    - a. For typical new walls:
      - 1) Conduit from outlet location to accessible ceiling then j-hooks to main run of cable tray.
    - b. For existing walls:
      - 1) For stud walls - "Ring and String": Mud ring for faceplate, cabling run in hollow cavity of the wall and then j-hooks are utilized back to the nearest cable tray or serving Telecommunications Room/Space
      - 2) For masonry or inaccessible walls – Surface-mounted raceway to accessible ceiling space.
    - c. See drawings for clarification
- D. Conduits
  1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
  2. Adequate access shall be available where cables enter conduits
  3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and with TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
  4. Install conduits in the most direct route possible, running parallel to building lines
  5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
  6. Conduits which enter Telecommunications rooms shall extend 3 inches AFF or through the wall.
  7. Conduits which enter Entrance Facilities shall extend 4 inches AFF or below the finished ceiling (if exists).
  8. Flexible conduits may only be used where specifically allowed by these contract documents.
    - a. Flexible conduit sections shall be less than 20 feet in length.
  9. No continuous section of a conduit may exceed 100 feet without a pullbox.
  10. For structured cabling, no more than (2) 90° bends, or equivalent will be allowed between pullboxes.
    - a. Each and any offset shall be considered a 90° bend.
    - b. A pullbox is required wherever a reverse bend is installed.
  11. The minimum bend radius for conduits is
    - a. (6) times the inside diameter for 2 inches conduits or less.
    - b. (10) times the inside diameter for conduits greater than 2 inches.
  12. Any single conduit run may not serve more than (1) outlet location unless expressly indicated on the drawings.
  13. Where building entrance conduits (for service provider and owner's WAN cabling) do not enter the building directly into the Communications Entrance Room/Facility, extend those entrance conduits via RMC or IMC into the Communications Entrance Room/Facility.
    - a. Coordinate with Contractor for Division 27 Sections "Communications Horizontal Cabling" for potential other pathways where IMC/RMC are required.
  14. Conduits shall contain no electrical condulets (also known as LBs).
    - a. Exception: Pre-approved (by the Design Consultant) condulets specifically manufactured for communications cabling and will maintain minimum bend radius for cabling to be installed. These locations are to be called out on the shop drawings.
  15. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.
  16. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.
- E. Outlet boxes
  1. No outlet boxes shall be located back-to-back in a wall cavity.
    - a. Where possible offset to next stud cavity, with a minimum of 6 inch (152.4 mm) separation.
  2. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
  3. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
  4. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.
- F. PullBoxes
  1. Pullboxes shall be placed in Conveniently Accessible locations.

2. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
3. Pullboxes above an accessible ceiling shall:
  - a. Be aligned directly over the ceiling grid to allow access
  - b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles
4. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
5. Size pullboxes according to the following chart (all sizes are minimums):

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
1" or smaller	4"	4"	2-1/8"	Not applicable
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	27"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	8"

G. Cable Tray

1. Cable trays shall be installed in accordance with the applicable electrical code and standards.
2. The inside of the cable support system shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) installed within the cable fill area shall have that portion within the tray rigidly protected with a smooth, non-scratching covering so that cable can be pulled without physical damage such as appropriately rated (plenum) plastic tubing.
3. Cables shall remain unattached to its pathway and shall simply lay at rest on the supports provided by its pathway. Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
4. Installation of cables shall not exceed the fill requirements stated above.
5. Cable trays shall not extend through fire-rated walls and walls for noise critical spaces.
6. Cable trays shall not extend over 6' lengths (or greater) of inaccessible ceilings. Stop cable trays just before the inaccessible ceiling and provide overhead conduits of quantity and size bridging the two sections of cable tray so that conduit cable capacity (square inches per fill ratio) is equal to that of the cable tray.
  - a. The cable fill ratio for cable tray shall be 50%.
  - b. The cable fill ratio for conduits shall be 40%.
  - c. Example: a 4" x 12" cable tray has 48 square inches of total capacity, and 24 square inches of cable capacity. Per the NEC, a 4" trade size EMT conduit has a 40% cable capacity of 4.62 inches. 24 divided by 4.62, rounding up to the next whole number equals (6) 4" conduits shall be provided for a 4" x 12" cable tray.
7. Cable trays and cable runways shall not be used as walkways or ladders.
8. A minimum of 12 inches (300 mm) access headroom shall be provided and maintained above a cable tray system or cable runway.
9. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access.
10. Basket cable trays shall be supported according to manufacturer's instruction via one of the following:
  - a. Trapeze/Unistrut under the cable connected to the cable tray and to (2) 3/8" (or greater) rods to structure above.
    - 1) Center-hung, single-rod supports are not allowed.
  - b. Shelf or L-brackets attached to wood or metal studs.
11. Test cable tray systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with maximum grounding resistance.

### 3.2 LABELING

A. Labeling Installation

1. Labels that are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on:

- a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section. Take picture of each firestopping system (with label visible) to include with Project Completion submittal.
- b. All pathways (e.g., conduit, innerduct, etc.) installed under this work.
  - 1) Label all conduit and innerduct with "TELECOM" or "AV" according to the intended system/use of the installed (or future) cabling. Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.
    - a) For wall stub-up locations, label overhead only.
    - b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.
      - i) Example – "AV to AV Rack R01".
    - c) For conduits that stub directly up or into a Communications Room, label both ends of conduit.
      - i) Example: underslab conduit from Telecom Room 1A to the Floor Box in Conference Room 101A shall be labeled as follows:
        - (1) Conduit stub-up location in Telecom Room 1A – "Telecom to Conf. Rm 101A Floorbox"
        - (2) Bottom of floorbox, immediately adjacent to serving Telecom conduit – "Telecom to Telecom Room 1A"
  - 2) All pullboxes and junction boxes for Communications shall be labeled such as "TELECOM PULLBOX", "TV", etc. on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.
    - a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie "To AV Box Q:212:01 in Control Rm 212".
  - 3) In addition to the above labeling requirements, for pathways above accessible ceiling, paint the cover of all pullboxes/junction boxes <insert color> and stripe all conduits every 5' with that color.
  - 4) Wherever raceways for future use are terminated outside of the building, stake the location with a 2-foot long, 1 inch x 1-inch clear heart redwood stake.
- c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.
- d. Refer to individual Division 27 Communications sections and to the drawings for additional information on labeling requirements.

### 3.3 FIRESTOPPING

#### A. General

1. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.
  - a. Assume all floors are fire-rated, unless otherwise noted.
  - b. Also install fire stops at any other locations indicated in the Specifications or Drawings.
3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
  - a. Fire stop Manufacturer
  - b. Installer and company
  - c. Date installed
  - d. UL system number with all relevant ratings indicated
4. Include labels in each telecom room in which one or more fire rated walls is installed. Provide a 2" block letter stencil label on the inside of the telecom room to indicate rating for each barrier.
5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.

#### B. Penetration Sealant – Conduits

1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.

#### C. Penetration Sealant – Voids, Cavities, and Openings

1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
  2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
  3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.
- D. Fire-Rated Pathway Device
1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.
  2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
  3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
  4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
  5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

**END OF SECTION 270500**



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## **SECTION 271000 - STRUCTURED CABLING SYSTEM**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. Provide a complete functioning telecommunications structured cabling system, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether 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, supplies, tools, equipment, transportation, and utilities.
- B. Specification sections 271000 through 271999, and Drawings numbered with prefix TN, generally describe these systems, but the scope of the Structured Cabling System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Electronic Safety and Security Drawings and Specifications; and Addenda.
- C. This section includes additional requirements for the Structured Cabling (Telecommunications) System, which include the following:
  - 1. Quality Assurance requirements, including Contractor qualifications and advanced warranties.

#### **1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 27 Section "General Communications Requirements".
- C. Division 27 Section "Common Work Results for Communications".
- D. Requirements of this Section apply to all Sections 271000 through 271999.

#### **1.3 STANDARDS**

- A. The references to the following standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts, and their addenda. The Contractor is responsible for following the correct revision or printing (UON):
  - 1. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
  - 2. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
  - 3. TIA-526 – "Standard Test Procedures for Fiber Optic Systems"
  - 4. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure"
  - 5. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
  - 6. ANSI/BICSI/NECA 568 – "Standard for Installing Commercial Building Telecommunications Cabling"
  - 7. ANSI/TIA-758 – "Customer-Owned Outside Plant Telecommunications Cabling Standard"
  - 8. ANSI/BICSI-001 "Information Transport Systems Design Standard for K-12 Educational Institutions"

#### **1.4 GUIDELINES**

- A. The references to the following guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts, and their addenda. The Contractor is responsible for following the correct revision or printing (UON)
  - 1. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
  - 2. BICSI Telecommunications Distribution Methods Manual (TDMM)
  - 3. BICSI Outside Plant Design Reference Manual (OSPDRM)

#### **1.5 DEFINITIONS**

- A. BICSI - Building Industry Consulting Service International

- B. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category 3/5e/6/6A copper cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.
- C. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

## 1.6 QUALITY ASSURANCE

- A. Personnel Qualifications:
  1. Always provide and maintain a BICSI Registered RCDD in good standing on staff as a full-time employee. This RCDD shall be familiar with the project and available to attend all scheduled project meetings when required by the Owner/Design Consultant. Weekly inspections and approval of all work performed shall be conducted by this RCDD.
  2. Provide and maintain a Project Manager whom is a BICSI Registered Certified Technician Level 2 Installer in good standing on site at all times. This project manager shall attend all scheduled project meetings and be responsible for all submittals.
  3. The person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
  4. Any additional personnel that will be physically installing any part of the telecommunications infrastructure covered by this division shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training certificate (of those identified as approved for this project) and approved by the Design Consultant.
  5. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
  6. Alternate qualifications may be considered if requested alternates are provided in accordance with the substitution section herein prior to bid.
- B. Contractor qualifications:
  1. Provide a list of projects (no less than 2) of similar size, scope, and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.
  2. The contractor must have a minimum of five (5) years' experience on similar cabling systems.
  3. The vendor must agree to e-rate guidelines, have a valid SPIN number AND have a SPAC form on file that is not outdated.
  4. The vendor must also have the necessary certifications to provide the nCompass Warranty offered between Legrand Ortronics and Superior Essex. The network cabling infrastructure must be installed by Supplier approved designers and Certified Contractors at the Certified Installer Plus-Enterprise Solutions Partner (CIP-ESP) tier or Certified Installer Plus (CIP) tier in accordance with manufacturer's installation instructions and specifications. Copies of certifications must be attached to the Vendor's response for evaluation by The Customer.

## 1.7 ADVANCED STRUCTURED CABLING SYSTEM WARRANTY

- A. All components, including but not limited to, connectors, terminal blocks, cabling and all other components considered to be a part of what is commonly referred to as an end-to-end solution for all backbone and horizontal cabling systems, shall be warranted for a minimum period of 20 years from the date of installation against defects in materials, equipment, and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/IEC/ISO standards for each cable system specified. This warranty shall also include all current and future applications designed for and becomes available under warranty for each cable system.
  1. Warranty shall be guaranteed by a single reputable manufacturer from below:
    - a. Legrand/Ortronics
    - b. Or Approved Substitution (submitted and accepted in the pre-bid submittal)
- B. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

- C. Perform the remedial work promptly, upon written notice from the Architect or Owner.
- D. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one-year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

#### 1.8 WORK INCLUDED

- A. Provide labor, materials, and accessories required to provide complete, operating Telecommunications Infrastructure systems as called for in the Contract Documents and in accordance with applicable codes and regulations. Labor, materials, or accessories not specifically called for in the Contract Documents, but required to provide complete, operating infrastructure systems shall be provided without additional cost to the Owner. The work includes, but is not necessarily limited to, the following:
  1. All horizontal cabling between the Telecommunications rooms and the outlets.
  2. All termination blocks, outlets/jacks, patch panels, patch cords, cabinets, equipment racks, etc., required to support, terminate and/or cross connect cabling at the main cross-connect, Telecommunication rooms and/or other designated equipment locations.
  3. All physical cable management hardware including, but not limited to: "J-hooks" in accessible ceiling areas, cable trays, conduits, ladder-type cable racks within telecommunication rooms and "D-rings" on backboards and equipment racks/cabinets/frames.
  4. A Grounding/Bonding System, as described in these construction documents.
  5. Termination, cross connect and patching of all cable pairs as indicated herein or on schedules or on drawings.
  6. Testing, labeling and documentation of all cables and hardware installed under this contract.
  7. Preparation and submission of shop drawings, testing reports, as-built drawings, and cabling documentation as described below.

#### 1.9 COORDINATION

- A. The locations of cable termination fields, outlets, patch panels, equipment racks and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.
- B. Exercise particular caution with reference to the location of outlets, patch panels, control panels, switches, etc., and have precise and definite locations accepted by the Architect before proceeding with the installation.
- C. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.
- D. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings.
- E. Outlet/cable tags in the form of alpha/numeric characters are used where shown to indicate the outlet and cable designation numbers in cable termination fields (terminal blocks and/or patch panels). Show the actual outlet/cable numbers on the as-built drawings, on the associated typed termination field labels and in the printed and computer readable cabling schedules. Where sample outlet/cable-numbering information is not indicated, request clarification from the Architect.
- F. The drawings generally do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Provide the correct cable type and quantity as required by the indicated outlets, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NEC and ANSI/TIA-568.
- G. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
  1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.

2. Provide offsets, transitions, and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

#### 1.10 SUBMITTALS

- A. Refer to requirements in Division 27 Section "General Communications Requirements". At a minimum, include the following items:
  1. Pre-bid submittal
    - a. Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
    - b. Alternate personnel credentials to be reviewed for approval
  2. Bid submittal
    - a. Bid Response Forms
    - b. Personnel Qualifications / Credentials - Supplemental to Division 1 requirements submit the following documents to indicate the required personnel qualifications per the quality assurance section of this section:
      - 1) Member of staff required to be RCDD
        - a) A copy of their valid RCDD certificate, RCDD number, and BICSI member number shall be provided with bidding documents.
      - 2) On-site project manager
        - a) A copy of their valid BICSI Certified Technician certificate and BICSI member number shall be provided with bidding documents.
      - 3) Other personnel physically installing any portion of the communications infrastructure.
        - a) A copy of their valid BICSI Commercial Installer certificate and BICSI member number shall be provided with bidding documents
        - b) An alternate certification may be considered by the Design Consultant for approval, which shall be completely at the Design Consultant's discretion.
        - c) If the contractor chooses to submit an alternate certification from one of the conditionally approved vendors lists as an acceptable alternate for a BICSI Commercial Installer, the following shall be included:
          - i) A valid copy of each certification with the person's name and member number including the manufacturer's logo
          - ii) A document provided by the manufacturer describing what specific subjects the certification covers, period spent doing course work required to gain certification, exam topics, and the requirements needed to maintain the certification.
      - 4) Contractor Qualifications (Previous project references)
      - 5) Voluntary Bid Alternates
    3. Pre-construction submittal
      - a. Warranty information
        - 1) Sample warranty certificate for the Advanced System Warranty, indicating manufacturer and terms/conditions
        - 2) Proof that Contractor is certified with the Advanced System Warranty manufacturer
      - b. Resubmit Contractor and Personnel Qualification, update if necessary
      - c. A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Order shall match that as in these specifications.
      - d. Manufacturers' cut sheets, in same order as typed list and in these specifications.
        - 1) At a minimum all cut sheets shall contain the following:
          - a) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
          - b) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo
          - c) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.
          - d) For cut sheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.
          - e) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
      - e. Shop Drawings

- f. And as required by individual sections in this Division
4. Project completion submittal
  - a. Preliminary Project Completion submittal requirements:
    - 1) To be submitted:
      - a) After all horizontal and backbone cabling has been installed, terminated, labeled, tested, and corrected so that all cables and strands pass the Testing Requirements.
      - b) In conjunction with the Substantial Completion Review request.
        - i) Design Consultant requires a minimum of 2 weeks' notice to schedule the on-site Substantial Completion Review.
        - ii) Substantial Completion Review shall be a minimum of 4 weeks before Substantial Completion, or earlier if the Project Schedule requires it, to allow for major Punch List items to be address by Contractor.
    - 2) Submittal shall include:
      - a) Scanned Work Site Prints that include horizontal and backbone cable/outlet labels that correspond to the Test Results.
      - b) Passing Test Results for all cables and strands, in the following formats:
        - i) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:
          - (1) Project Name
          - (2) Date of Preparation
          - (3) ID of Work Area Outlet / connector being tested
          - (4) Date of test
          - (5) Contractor's Name
          - (6) Media Type
          - (7) Make, Model, and Serial Number of test equipment used
          - (8) Date of last calibration
          - (9) Names of test crew
          - (10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
          - (11) Category or type of cable being tested
          - (12) Pass or Fail status
        - ii) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:
          - (1) Project Name
          - (2) Date of Preparation
          - (3) ID of Work Area Outlet / connector being tested
          - (4) Date of test
          - (5) Contractor's Name
          - (6) Media Type
          - (7) Make, Model, and Serial Number of test equipment used
          - (8) Date of last calibration
          - (9) Names of test crew
          - (10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
          - (11) Category or type of cable being tested
          - (12) Full Test Result Data (per Part 3 of this specification)
  - b. Final Project Completion submittal requirements:
    - 1) Advanced Structured Cabling System Warranty Certificate. Warranty terms and conditions shall contain the following:
      - a) Length of warranty period
      - b) Applications covered (future and present)
      - c) Single manufacturer responsible for fulfilling warranty
      - d) Covered services and products
      - e) All disclaimers, limitations, etc.
      - f) What, if anything, is not covered
    - 2) Product Information
      - a) Product List (Bill of Materials) – a typed list of products (in order of these specifications), in Excel or CSV file format, indicating:
        - i) Product Type (as identified in these specifications)
        - ii) Manufacturer
        - iii) Model Number
        - iv) Quantity installed
        - v) Serial Number (if applicable)

- vi) Manufacturer Warranty date (if longer than 1 year)
  - b) Manufacturer Cut Sheets / Specification Sheets
  - c) Operation and Maintenance Manuals – manufacturer's installation, service, and maintenance instructions.
  - d) Warranty certificates (for products not covered by the Advanced System Warranty)
    - i) If products require registration, register on the Owner's behalf.
- 3) As Built Drawings
- a) At the completion of the project, incorporate changes to the Structured Cabling System noted on the jobsite work prints onto a set of as built Drawings. These changes shall be done electronically and saved to PDF format.
  - b) Include date and installing contractor's logo and contact information in the title block.
  - c) Mark each sheet "As Built Drawing".
  - d) Drawings shall include:
    - i) Corrected items from Substantial Completion Review punch list.
    - ii) Cable ID (all characters) for each work area outlet jack (so that they are searchable in the PDF version)
    - iii) Routing of cable/conduit/cable tray and location of any firestopping systems and pull boxes.
    - iv) Project RCDD's stamp, which indicates that the project has been installed in compliance with industry standards and the contract documents.
- 4) Updated, complete Test Results in the following formats (to include the retesting data of any cables installed or modified after Preliminary Project Completion submittal):
- a) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:
    - i) Project Name
    - ii) Date of Preparation
    - iii) ID of Work Area Outlet / connector being tested
    - iv) Date of test
    - v) Contractor's Name
    - vi) Media Type
    - vii) Make, Model, and Serial Number of test equipment used
    - viii) Date of last calibration
    - ix) Names of test crew
    - x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
    - xi) Category or type of cable being tested
    - xii) Pass or Fail status
  - b) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:
    - i) Project Name
    - ii) Date of Preparation
    - iii) ID of Work Area Outlet / connector being tested
    - iv) Date of test
    - v) Contractor's Name
    - vi) Media Type
    - vii) Make, Model, and Serial Number of test equipment used
    - viii) Date of last calibration
    - ix) Names of test crew
    - x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
    - xi) Category or type of cable being tested
    - xii) Full Test Result Data (per Part 3 of this specification)

- B. Each structured cabling section (271000-271999) shall be submitted individually. All structured cabling section submittals (271000-271999) shall be submitted on the same date. "Piecemeal" submissions will not be reviewed.
- C. For each room or area of the building containing Structured Cabling System infrastructure and equipment, submit the following as part of the shop-drawings and as-built drawings:
1. Floor plans, at not less than 1/8" scale, showing routing of Communications conduits, cable trays, and wireways, including surface-mounted raceways and pull boxes. Also show the routing of bundles of cables supported by "J-hooks", or similar means, if and where such installation practices are allowed by the Contract Documents.



- a. Outlet locations shall be identified with jack/module type and label. Coordinate labeling scheme with Owner prior to submitting.
  2. Riser diagrams showing types, quantities and schematic routing of all Communications backbone pathways, cabling and the TBB and TBC.
  3. Enlarged plan views and elevation layout drawings for the Telecommunications Entrance Facility Room, Telecommunications Rooms and all other designated Telecommunications Equipment Rooms indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than  $\frac{1}{4}$  inch = 1'-0". They shall be prepared in the following manner:
    - a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
    - b. Illustrate all Communications equipment proposed to be contained therein. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
    - c. Illustrate all other equipment therein such as conduits, detectors, lighting fixtures, ducts, registers, pull boxes, wireways, structural elements, etc.
    - d. Indicate the operating weight of each piece of equipment.
    - e. Indicate dimensions to confirm compliance with code-required clearances.
    - f. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation). (Note: This requirement applies to active Communications equipment such as LAN hubs, routers, amplifiers, radio transmitters/receivers, PBX, or key telephone equipment, etc., if installed under this work.)
    - g. Equipment removal routes for individual equipment items with plan dimensions exceeding 24" by 36" or height exceeding 84".
- D. The Communications Equipment room layout submittals and the related Structured Cabling System submittals shall be submitted concurrently. Failure to submit concurrently may result in the immediate return of the submittal marked REVISE AND RESUBMIT.

#### 1.11 SPARE PARTS

- A. Furnish to the Owner the following spare parts as part of the complete Structured Cabling System:
  1. Furnish one general purpose 110-style punch down tool.
  2. Any custom or proprietary copper Category cable termination tool. Furnish one per Communications Room.
  3. Furnish (and install select) Patch Cables in quantities, lengths, and colors as specified in Division 27 "Telecommunications Equipment Room Fittings".
  4. Additional Special Tools, as defined in Part 3 of this specification.
- B. Have these spare parts in the Main Communications Room during Design Consultant's Site Observation Review visit; turn over to Owner before Substantial Completion.

### **PART 2 - PRODUCTS**

#### 2.1 110-STYLE PUNCHDOWN TOOL

- A. Manufacturer shall be Panduit PDT-110 or equivalent.

#### 2.2 COPPER TESTING EQUIPMENT

- A. Category 6 Cable Tester
  1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
    - a. Category 6 Cable Tester
      - 1) Fluke
      - 2) Ideal
      - 3) Softing
      - 4) Viavi
  2. Requirements
    - a. The field tester shall be a level III or greater.
    - b. The field tester shall meet the requirements of ANSI/TIA-568.
- B. Augmented Category 6 Cable Tester
  1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

- a. Augmented Category 6 Cable Tester
  - 1) Fluke
  - 2) Ideal
  - 3) Softing
  - 4) Viavi
- 2. Requirements
  - a. The field tester shall be a level III-E (Ille) or greater.
  - b. The field tester shall meet the requirements of ANSI/TIA-568.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION, GENERAL**

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

#### **3.2 IDENTIFICATION / LABELING**

##### **A. General**

- 1. Labels or tags containing a unique cable ID designator as specified on the drawings or herein shall be placed on both ends of all cables, 6 inches (152.4 mm) from the connector and/or terminal block.
- 2. Label or tag all cables passing through Telecommunications rooms.
- 3. Subsequent to placing and terminating cables, place the appropriate cable label.
- 4. The administration of the Telecommunications infrastructure includes:
  - a. Labels (plates, tags, etc.) to identify individual components.
  - b. Schedules (or other records (printed and/or in computer data base form) to document information about the individual components and the relationships between them.
  - c. Plans or drawings to assist with visualizing the physical and/or logical locations of the components.
- 5. Provide labels on all applicable items installed under this work and to provide all related records and drawings so that the Owner will be able to administer the telecommunications infrastructure.

##### **B. Labeling Installation**

- 1. Labels that are to be secured by adhesive shall have a type of adhesive that is appropriate for the surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.
- 2. Labels, plates, and tags are to be installed in such a manner that they will be accessible, both physically and visually, after completion of the work. (Exception: It is understood that labels on the outlet end of station cables are generally not visible unless the face plates, bezel, module, etc., is removed or opened.)
- 3. Any temporary labels used during installation, cable pulling, etc. are to be removed and replaced by the permanent labels identified in Part 2 of this specification before the work will be accepted.
- 4. If at any time during the job the cable tag becomes illegible or removed for whatever reason during the construction period, immediately replace it with a duplicate pre-printed cable tag at the Contractor's expense before the work will be accepted.

##### **C. Labeling Requirements**

- 1. Labels, plates, and tags are to be installed on:
  - a. All Telecommunications rooms (spaces).
  - b. All horizontal links and their components, including:
    - 1) Attaching a label, no more than 6 inches (152.4 mm) from both ends of all horizontal cables installed under this work.
    - 2) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
    - 3) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work.
    - 4) Labeling the Telecommunications outlet housing individual connectors in the work area.
      - a) Labeling each connector terminating horizontal cables in these outlets.
      - b) Label identification within a given space (work area) shall begin at the entrance to the space and proceed in a clockwise manner around the space.
    - 5) Any additional components required by ANSI/TIA-606
  - c. All components of the commercial grounding and bonding system for Telecommunications; to include but not limited to all bonding conductors, PBB and SBB's.
  - d. All required fire stopping systems.

- e. All pathways (e.g., inner duct, cable racking, conduit, etc.) installed under this work.
    - 1) All interior pathways including cable trays and conduits shall be striped, traced, colored, or marked.
  - f. Provision of a database that records appropriate information regarding all cabling, terminations, frames, racks, etc. installed under this work.
  - g. In general, the label, plate or tag is to be provided and installed by whoever installed the item that is being labeled.
  - h. Refer to individual Telecommunications specification sections (Division 27) and to the Telecommunications drawings for additional information on labeling requirements.
2. Field termination labeling requirements:
- a. Installed behind the factory transparent plastic protector clearly indicating the closet, panel and port number.
    - 1) For example, in IDF L, jack locations are to be labeled by closet, panel and then port number.
      - a) "L-2-01" would represent Closet L, Panel 2, Port 01.
    - 2) Label numbers should be above the termination box ports and endpoint terminations should always start at the top of the endpoint termination box.
    - 3) Numbers should be sequential in order where possible.
      - a) For example, on a two-port box, labels would be at the top. In a three-port example, two labels would be at the top and one would be at the bottom.
      - b) All labeling starts at the top left of the box.

### 3.3 TEST REPORTS FOR THE STRUCTURED CABLING SYSTEM

- A. General cable testing
  - 1. Pre-installation testing:
    - a. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
    - b. Where post-manufacturer test data has been provided by the manufacturer on the reel, box or shipping carton: submit copies to the Owner prior to installing cables.
    - c. Mark reels or boxes as tested/inspected and submit associated test results to Owner/Design Consultant.
    - d. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.
  - 2. Post-installation testing:
    - a. Calibrate all testers prior to use in accordance with manufacturers' printed instructions.
    - b. Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.
    - c. Remove all defective cables from pathway systems. Do not abandon cables in place.
  - 3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.
    - a. Prior to testing, submit for review and approval copies of test report forms proposed for use.
    - b. Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.
- B. Copper cable testing
  - 1. Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.
  - 2. Paired and multi-conductor riser metallic cables:
    - a. After terminating and splicing the cables. Test all cable pairs for continuity, ground fault, proper cross-connection, shorts, and crossed pairs.
    - b. After installing cross-connects, perform end-to-end testing of each cross-connected cable pair for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
    - c. Cable test reports: As a minimum, also provide cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair, results of each test for each pair or conductor, total number of serviceable pairs or conductors in cable.
  - 3. Four-Pair Cables:
    - a. After terminating both ends of all 4-pair cables, but before any cross-connects are installed, test these cables for the following:
      - 1) Category 6 UTP
        - a) Wire map
        - b) Length
        - c) Insertion loss

- d) Near-end crosstalk (NEXT) loss.
  - e) Power sum near-end crosstalk (PSNEXT)
  - f) Equal-level far-end crosstalk (ELFEXT)
  - g) Power sum equal-level far-end crosstalk (PSELFEXT)
  - h) Return loss
  - i) Propagation delay
  - j) Delay skew
- 2) Augmented Category 6 F/UTP Cables
  - a) Wire map
  - b) Length
  - c) Insertion loss
  - d) Near-end crosstalk (NEXT) loss.
  - e) Power sum near-end crosstalk (PSNEXT)
  - f) Equal-level far-end crosstalk (ELFEXT)
  - g) Power sum equal-level far-end crosstalk (PSELFEXT)
  - h) Return loss
  - i) Propagation delay
  - j) Delay skew
  - k) Alien Crosstalk (AXTalk) – Follow manufacturer's instructions for method
- 4. After installing cross-connects, perform end-to-end testing of each cross-connected cable for continuity, ground fault, proper cross-connection, shorts and crossed pairs. For 100 pair or smaller cables, replace entire cable if bad pair is found. For larger pair-count cables, replace if more than 1% of pairs are bad.
- 5. Submit the following information regarding the cable testing: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair (if applicable), results of each test for each pair and total number of serviceable pairs in cable.
- 6. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and copper test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable tests as requested. Successful equipment performance tests do no relieve the Contractor from the specified testing, repair, and documentation requirements.

C. Acceptance

- 1. The Owner and Design Consultant reserve the right to observe the conduct of any or all portions of the testing process.
  - a. The Owner and Design Consultant further reserves the right to request the Contractor conduct a random re-test of up to ten percent (10%) of the cable plant to confirm documented test results during the Substantial Completion Review. If more than 5% of these randomly tested cables do not pass, the Owner and Design Consultant reserves the right to require a re-testing of 100% of the cable plant, all without additional costs to the project.
- 2. For 100 pair or smaller replace entire cable if a bad pair or conductor is found. For larger pair count cables, replace if more than 1% of pairs are bad.
- 3. All test results are to be documented and submitted to the Architect in a timely manner, in accordance with the Submittal instructions in Part 1 of this section.
  - a. Corrective procedures following the Substantial Completion Review shall be properly documented, and affected and new cables shall be retested prior to Substantial Completion.
  - b. Updated complete Test Results, including retested, new, and unaffected cables, shall be included in the Final Project Completion submittal.

### 3.4 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
  - 1. The complete build-out of all Communications Rooms, cleaned of dust and debris.
  - 2. Installation, termination, final labeling, and testing of all backbone and horizontal cabling.
  - 3. The installation and labeling of all firestopping systems required for Telecommunications cabling and outlets. If firestopping was provided by a separate contractor (per Division 27 "Common Work Results for Communications"), ensure all firestopping systems are installed and labeled.
  - 4. The installation, labeling, and testing of the Telecommunications Grounding and Bonding System.
  - 5. Ensure faceplates are level, free of dust and paint, match color/style of adjacent electrical receptacle, and have blue protective film removed.

6. Update jobsite Work Prints with all individual port / cable IDs, which shall correspond to the cable IDs in the Test Results.
  - a. These shall then be scanned to PDF (minimum resolution of 150 dpi) to be included in the Preliminary Project Completion documentation outlined in the Part 1 Submittal requirements earlier in this section.
- B. Request in writing a review for Substantial Completion. Refer to Part 1 Submittal requirements earlier in this section for required notice and Preliminary Project Completion documentation that shall be included with this request.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion for the (Telecommunications) Structured Cabling System.
- D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

### 3.5 SPECIAL TOOLS

- A. Delivery to Owner's representative 2 complete sets (UON) of all special tools and small equipment items needed for proper operation, adjustment and maintenance of cabling and equipment installed under this work. All tools to be new and still in manufacturers packaging. The cost for these tools is to be included within the bid price for this work.
- B. The terms "special tools" and "small equipment items" is meant to include such items as punch down tools, connector assembly tools, etc. with each individual item having a retail replacement cost not exceeding five hundred dollars (\$500.00). It is NOT meant to include common hand tools such as standard screwdrivers, pliers, wrenches, etc.

### END OF SECTION 271000

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## **SECTION 271100 - TELECOMMUNICATIONS EQUIPMENT ROOM FITTINGS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. Section includes fittings that are within the physical walls of the communications equipment rooms to support the Telecommunications System. Fittings include but are not limited to:
  - 1. Termination Blocks and Patch Panels
  - 2. Patch Cables
  - 3. Cable Management
- B. Section does not specify fittings such as cables, cable terminations, or faceplates for structured cable system (SCS). These components are specified in the Division 27 Section "Communications Backbone Cabling" and Division 27 Section "Communications Horizontal Cabling".

#### **1.2 RELATED SECTIONS INCLUDE THE FOLLOWING**

- A. Follow all applicable codes, references, and standards listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".
- B. Division 27 Section "Seismic Controls for Communications"
- C. Division 26 Section "Grounding and Bonding for Electrical Systems".

#### **1.3 DEFINITIONS**

- A. Backbone Bonding Conductor (BBC) – The conductor that interconnects elements of the telecommunications grounding infrastructure.
- B. Communications Equipment Room – This term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).
- C. Communications Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass protection devices and fittings described in Article 770 "Optical Fiber Cables and Raceways" and Article 800 "Communications Circuits" of NFPA 70 "National Electrical Code".
- D. Communications Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19" or 23" inches.
- E. Communications Rack – A floor or wall mount unit without side panels. Racks can be 2-post or 4-post. Communications equipment is supported by mounting rails separated at 19" or 23" inches.
- F. Communications Frame - A floor or wall mount unit without side panels. Communications termination blocks are the only communications devices mounted to the unit.
- G. Communications Enclosure – A floor or wall mount unit enclosed with side panels. Communications equipment is not supported by mounting rails separated by 19" or 23" inches. This definition shall encompass BICSI Telecommunications Distribution Methods Manual term for Telecommunications Enclosure (TE).
- H. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- I. Primary Bonding Busbar (PBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

- J. Secondary Bonding Busbar (SBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.
- K. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).
- L. Telecommunications Bonding Conductor (TBC) – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

#### 1.4 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements", as well as the detailed Submittal requirements in Section "Structured Cabling System". The following additional items shall be submitted:
- B. Pre-Bid Phase:
  - 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- B. "Pre-construction" submittal:
  - 1. Shop Drawings:
    - a. Submit for review scaled layout drawings showing the layout of equipment racks, ground bars, wall mounted equipment and termination blocks, conduits, and ladder rack within telecom rooms. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System shop drawings for individual areas.
  - 2. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
  - 3. Submit manufacturers' cut sheets or catalog cut sheets for each product specified.
- C. "Project Completion" submittal:
  - 1. As-built Drawings:
    - a. Submit scaled layout drawings showing the layout of all equipment and pathways in telecom rooms with final identifiers if applicable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System Record Drawings for individual areas.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.
- B. Communications equipment room fittings shall be listed by a NRTL.

#### 1.6 WARRANTIES

- D. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

### **PART 2 - PARTS AND MATERIALS**

#### 2.1 TELECOMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

- A. General
  - 1. All telecommunications termination blocks and patch panels shall be by the same manufacturer and covered under the same Advanced Structured Cabling System Warranty.
    - a. The following manufacturers are Conditionally Approved:
    - b. Ortronics
    - c. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)



- B. Rack-mount Modular - Copper Patch Panels
1. General Requirements for Patch Panels: Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.
  2. Patch panels shall be provided complete with all mounting hardware, jacks, retainers, wire guides, designation strips, etc.
  3. Patch panels shall accept modular jacks of exactly one port, and this modular jack shall be the same type as being installed at the far-end faceplates.
  4. Provide enough ports for the number of cables terminated on the patch panel, plus 25 percent spare. Provide all connector blocks', including plugs and jacks where required to fill each panel completely. Do not leave any blank openings.
  5. Modular Patch Panels shall be of a metal design with snap in module frames for each individual jack.
  6. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard EIA 19" racks.
  7. Horizontal Cabling
    - a. Four-pair Augmented Category 6 and Category 6 UTP cabling shall be terminated onto a four-pair Augmented Category 6 and Category 6 jack module. All jack modules shall be terminated using the T568B wiring scheme. The eight-position jack module shall exceed the connector requirements of the TIA Augmented Category 6 and Category 6 standard.
  8. Submit Manufacturer and part number as part of pre-construction submittals.

## 2.2 TELECOMMUNICATIONS PATCH CABLES & CROSS-CONNECT WIRES

- A. General
1. Supply all necessary patch cables and cross-connect wires as part of a complete and functioning telecommunications system to support voice, data, audio-video, security, and other miscellaneous systems.
  2. The manufacturer of patch cables shall be the same as the telecommunications connectivity, unless otherwise specified.
  3. All patch cables shall be factory-terminated and tested.
- B. Copper Cross-Connect Wires
1. Provide cross-connect wires as indicated on the drawings and as required to form a complete and functioning telecommunications system. This includes extension of analog voice lines from the service provider demarcation point to the following connections:
    - a. Security Panels
  2. Manufacturer shall be:
    - a. Same as copper connectivity manufacturer
    - b. Submit product cutsheet for review
- C. Copper Patch Cords
1. Category performance shall be the same as copper patch panels.
  2. Cable shall be 4-pair, twisted pair with factory-terminated RJ-45 modules on each end.
  3. Provide (furnish and install) all patch cords required for the following connections and systems (coordinate color, length, and quantity with sub-contractors of those systems):
    - a. LAN connections Security Systems equipment and cameras
  4. Furnish patch cords to the Owner prior to substantial completion in the following lengths and quantities:
    - a. Total quantity shall be 100% of the terminated ports, in the following colors and lengths:
      - 1) One-fourth shall be 3' and yellow
      - 2) One-fourth shall be 3' and blue
      - 3) One-fourth shall be 7' and blue
      - 4) One-fourth shall be 10' and blue
  5. Manufacturer shall be:
    - a. Same as copper connectivity manufacturer
    - b. Submit product cutsheet for review

## 2.3 TELECOMMUNICATIONS CABLE MANAGEMENT

- A. Vertical Cable Managers
1. Manufacturer shall be the same as equipment racks and cabinets, unless otherwise noted.
  2. Color: black
  3. Size: as specified on drawings, or a minimum of 6" wide by 6" deep, whichever is greater.
  4. The following manufacturers are Conditionally Approved:

- a. B-Line
- b. Chatsworth Products
- c. Ortronics
- d. Panduit
- e. Or connectivity manufacturer carrying structured cabling warranty
- f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION, GENERAL**

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

#### **3.2 QUANTITIES OF RACK/CABINET AND DISTRIBUTION FRAME EQUIPMENT AND COMPONENTS**

- A. Location and placement of communications equipment room fittings shall be as shown on the Drawings or defined in these specifications and schedules.
- B. Quantities and sizes of communications equipment room fittings shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of all materials necessary to accommodate the work described in these specifications and schedules and shown on the Drawings.
- C. Equipment racks, cabinets and distribution frames shall be assembled and installed as per the manufacturers' printed instructions.

### **END OF SECTION 271100**

## **SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. Provide a complete Category 6 and Category 6A horizontal (work area) telecommunications cabling system as shown on the TN sheets and in accordance with these Contract Documents.
- B. This section specifies the following:
  - 1. Horizontal Copper Cable
  - 2. Copper Connectivity
    - a. Faceplates
    - b. Surface Box
    - c. Jacks/plugs/inserts

#### **1.2 RELATED SECTIONS INCLUDE THE FOLLOWING**

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"
- B. Refer to Division 27 Section "Common Work Results for Communications" for general pathway, firestopping, access panel, identification, and other requirements.
- C. Refer to Division 27 Section "Structured Cabling System" for Advanced System Warranty information and other requirements.
- D. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for telecommunications equipment racks, patch panels, wall-blocks, surge suppressors, and other equipment room requirements.

#### **1.3 CODES, STANDARDS, AND GUIDELINES**

- A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System", follow the most recent editions of the following:
  - 1. NFPA 70 (NEC) – "National Electrical Code" (NEC)
  - 2. IEEE NESC - "National Electrical Safety Code"
  - 3. ANSI/BICSI 005 – "Electronic Safety and Security System Design and Implementation Best Practices"
  - 4. ANSI/NECA/BICSI-607 – "Standard for Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings"
  - 5. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
  - 6. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
  - 7. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
  - 8. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure"
  - 9. BICSI – "Telecommunications Distribution Methods Manual"
  - 10. BICSI – "Information Technology Systems Installation Methods Manual"
  - 11. IEEE 142 – "Recommended Practice for Grounding of Industrial and Commercial Power Systems" (Green Book)
  - 12. IEEE 1100 – "Recommended Practice for Powering and Grounding Electronic Equipment" (Emerald Book)
  - 13. TIA-526 – "Standard Test Procedures for Fiber Optic Systems"

#### 1.4 DEFINITIONS

- A. Advanced System Warranty – refer to Division 27 Section “Structured Cabling System”.
- B. Communications Equipment Room - This CSI MasterFormat term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).
- C. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.
- D. Horizontal Cabling
  - 1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
    - a. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector
    - b. Bridged taps and splices shall not be installed in the horizontal cabling
    - c. Splitters shall not be installed as part of the optical fiber cabling
  - 2. A work area is approximately 100 sqft, and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
  - 3. The maximum allowable horizontal cable length for Category copper cable is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.
  - 4. Horizontal cables longer than 295 feet shall be hybrid optical fiber and power conductor cable with a Power Over Ethernet Extender transmitter/receiver on each end.
- E. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed copper Category and fiber optic cable terminated onto a patch panel or outlet.

#### 1.5 QUALITY ASSURANCE

- A. As a minimum, the person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
- B. All testing equipment used shall have the latest version of software and/or firmware installed prior to testing any cabling. Testing equipment shall also undergo all manufacturers' required and recommended routine maintenance.

#### 1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”
- B. Pre-bid submittal
  - 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- C. Bid submittal
  - 1. Provide unit prices for the following:
    - a. The addition/deletion of individual horizontal cables. Include costs to furnish, install, terminate, test, label, etc, including backbox and conduit stubbed up to accessible ceiling space and j-hook supports every 5' to nearest cable tray or telecom room. Express costs on the basis of a run of up to 150 feet.

D. Pre-construction submittal

1. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters)
2. Submit manufacturers' cut sheets or catalog cut sheets for:
  - a. Each of the cables specified. Cut sheets shall include the following information at a minimum:
    - 1) Manufacturers name and logo
    - 2) Cable outside diameter
    - 3) Number of conductors/strands in each cable and binder group
    - 4) Gauge or strand thickness
    - 5) Minimum transmission performance rating
    - 6) Cable jacket material and rating
    - 7) Maximum pulling tension
    - 8) Jacket/Sheath color
    - 9) Individual conductor or strand insulation colors
    - 10) Minimum bend radius
      - a) During installation and post installation.
      - b) As well as any additional information required by individual sections of this Division.
  - b. Faceplates and modules. Cut sheets shall include the following information at a minimum:
    - 1) Manufacturers name and logo
    - 2) Material type
    - 3) Performance rating
    - 4) Physical Dimensions
    - 5) Color
  - c. Product information of test equipment to be used for the testing of cabling.
  - d. Provide documentation indicating manufacturer required and recommended maintenance and calibration services and intervals at which these services shall be performed.
    - 1) Provide documentation indicating the dates at which all testing units have undergone these services. For services required on a daily or pre-test basis provide documentation on the procedures the contractor will undergo for performing such services.
3. Shop Drawings
  - a. Submit for review scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels are to be installed.
  - b. Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks to be installed (including those to accommodate 25% growth).
  - c. Each individual outlet on the drawings shall have proposed outlet identification indicated.
  - d. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same shop drawing.
4. Testing
  - a. Qualifications: Identity and qualifications of the personnel who will perform the testing as required above in the Quality Assurance paragraph.
  - b. Submit all physical characteristics needed for appropriate testing setup and verification. I.e. Nominal velocity of propagation (NVP) for each and every cable type. This parameter shall be identified and submitted for review. Such submittals for all parameters shall be from printed manufacturers' cut-sheets or other manufacturers' printed material.
  - c. Submit the proposed schedule for performing testing at least 2 weeks prior to the start of testing.
5. Sample warranty information as indicated herein and elsewhere in this Division.

E. Project completion submittal

1. As-built Drawings
  - a. Submit scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels have been installed.
  - b. Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks installed (including those to accommodate 25% growth).
  - c. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same As-built drawing.
2. After approval by the Owner, submit the test results in two computer readable copy in CD, DVD or mutually acceptable format by the Contractor and Owner.
3. Advanced Structured Cabling System Warranty Certificate

## 1.7 WARRANTIES

- A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 HORIZONTAL (WORK AREA) COPPER CABLE

- A. Horizontal cables for dry environments
1. Requirements
    - a. Unshielded Twisted Pair (UTP)
    - b. Minimum performance specifications: Cable shall meet requirements for Category 6 and Augmented Category 6 of ANSI/TIA-568.
    - c. Four pairs of 22-24 AWG solid copper conductors
    - d. Cable jacket color(s) shall be
      - 1) Blue for Category 6 cables and Category 6A
    - e. Cable jacket marking: Shall be legible and shall contain the following information:
      - 1) Manufacturer's name
      - 2) Copper Conductor Gauge
      - 3) Pair Count
      - 4) UL and CSA listing
      - 5) Manufacturer's trade mark
      - 6) Category rating
      - 7) Sequential distance markings, in one foot increments
    - f. Individually insulated conductors under a common sheath
    - g. Plenum (CMP or MPP) rated.
  2. Manufacturer shall be:
    - a. Superior Essex (CMP 66-240-xB)
    - b. Superior Essex (CMP 6H-272-xB)
    - c. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- B. Horizontal cables for Wet Locations (as defined in Division 27 Section "Structured Cable System")
1. Requirements
    - a. Suitable to be in contact with standing water
    - b. Cable construction shall be consistent with manufacturer's requirements to be covered under warranty specified in Division 27 Section "General Communications Requirements".
    - c. Minimum performance specifications: Cable shall meet requirements for Category 6 and Augmented Category 6 ANSI/TIA-568.
    - d. Cable jacket marking: Shall be legible and shall contain the following information:
      - 1) Manufacturer's name
      - 2) Copper Conductor Gauge
      - 3) Pair Count
      - 4) UL and CSA listing
      - 5) Manufacturer's trade mark
      - 6) Category rating
      - 7) Sequential distance markings, in one foot increments
  2. Product shall be:
    - a. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

### 2.2 FACEPLATES FOR COPPER CONNECTIVITY

- A. Single-gang faceplate:
1. Requirements
    - a. High impact nylon with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
    - b. Color shall be fog white, U.O.N. by owner
    - c. Single gang, U.O.N
  2. Product shall be
    - a. Ortronics OR-403HDJ16

- b. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- B. Double-gang faceplate:
  - 1. Requirements
    - a. High impact nylon with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
    - b. Color shall be fog white, U.O.N. by owner
    - c. Double gang, U.O.N
  - 2. Product shall be
    - a. Ortronics OR-403HDJ212
    - b. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- C. Weatherproof faceplate:
  - 1. Requirements
    - a. Water resistant faceplate (to IP56 rating, or equivalent) with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
    - b. With in-use cover
  - 2. Product shall be:
    - a. Panduit Mini-Com Water Resistant Faceplate with integral cover.
    - b. Hubbell RW57300 (Or Approved Equivalent) with decora-insert and jacks from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements).
- D. Surface mount box
  - 1. Requirements
    - a. With number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
    - b. Mount into backbox, U.O.N
  - 2. Product shall be
    - a. Ortronics OR-404HDJ2 (fog white) for locations with two or less cables
    - b. Ortronics OR-404HDJ4 (fog white) for locations with three or four cables
    - c. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

## 2.3 COPPER CONNECTIVITY

- A. Modular jacks
  - 1. Requirements
    - a. Outlets shall meet requirements for Category 6 and Augmented Category 6 ANSI/TIA-568.
    - b. All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.
    - c. Outlet hardware shall be UL listed.
    - d. One port
    - e. Color shall be fog white, U.O.N. by owner
  - 2. Product shall be
    - a. Ortronics OR-HDJ6
    - b. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- B. Field termination plugs
  - 1. Requirements
    - a. Outlets shall meet requirements for Category 6 and Augmented Category 6 of ANSI/TIA-568.
    - b. All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.
    - c. UL Listed: UL 2043 (plenum)
  - 2. Product shall be
    - a. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- C. Blank inserts
  - 1. Requirements
    - a. Provide blank modules to fill any unused openings in faceplates
    - b. Color shall match other jack colors
  - 2. Product shall be

- a. Ortronics OR0HDJB (fog white)
- b. Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION, GENERAL**

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

#### **3.2 CABLE INSTALLATION**

##### **A. General**

1. Place all horizontal cabling in accordance with these specifications, on the Drawings, and as indicated on any cable schedules
2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
  - a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
  - b. There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.
    - 1) Horizontal cabling shall be terminated in a Telecommunications room that is on the same floor as the area (outlet) being served in accordance with ANSI/TIA-568.
    - 2) No horizontal Category cables shall exceed the allowed maximum distance of 295 feet (90 meters) by ANSI/TIA-568.
    - 3) Horizontal cables longer than 295 feet shall be hybrid optical fiber and power conductor cable with a Power Over Ethernet Extender transmitter/receiver on each end.
3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system. Refer to the electrical drawings for the layout of the conduits. Refer to the Telecommunications drawings for layout of cable tray.
  - a. All horizontal cables shall be plenum (CMP, MPP, OFNP, or OFCP) rated. UON
  - b. Horizontal cables installed in "wet" locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
  - a. Except when supported by ladder racking within each Telecommunications room, UON.
5. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.
6. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
7. Comply with all referenced standards and guidelines.
8. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
9. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the work area outlet and one at the Telecommunications room/enclosure. Each slack/service loop shall be:
  - a. A minimum of 8 feet in length, UNO
  - b. Configured in a loosely formed figure eight configuration (i.e. not coiled)
10. Prior to using any cable pulling lubricants provide the Engineer with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.

- B. Outside plant cable installation: for cables placed in "wet locations" or as required by these construction documents. (i.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)



1. Unlisted cables shall transition to an indoor rated cable within 50 feet (15.24 meter) of the entrance point as required the NEC.
  - a. This 50 feet (15.24 meter) allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)
2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.
  - a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.
4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50 feet (15.24 meter) of the transition point to indoor rated cabling in accordance with the NEC.
5. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Communications Equipment Room Fittings"

C. Horizontal (work area) Cables:

1. From the appropriate Telecommunications room, provide each work area outlet, the types and quantities of horizontal cables as described in the applicable system specification sections. Cables will leave the Telecommunications room via cable tray, conduit/sleeve or floor duct. Each cable will be terminated except for pay phone and elevator machine room junction box locations.
2. Install all horizontal cables in accordance with Division 27 Section "Common Work Results for Communications" and as indicated on the drawings.

### 3.3 CABLE & WIRE INSTALLATION

A. General:

1. Place all station cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.

B. Cables located in "wet" locations

1. Provide all required entrance protection in accordance with Division 27 "Communications Equipment Room Fittings".
2. Follow the requirements for installing outside plant rated cable as specified in Division 27 Section "Communications Horizontal Cabling"
3. All cables routed to floor boxes in the slab shall route to a transition box within 50 feet (15.24 meter) of where the conduit emerges from the slab. Provide connecting hardware within an appropriately rated enclosure to allow a transition from outside plant cable to indoor rated cable. Indoor rated cable shall be rated as required by building code and as specified herein. Route indoor cables as indicated for horizontal cable distribution. Transition hardware shall meet or exceed the category performance of the highest rated cable being terminated.
  - a. Cables from multiple different floor boxes may be routed to a single, appropriately sized, transition enclosure.

### 3.4 CONNECTOR INSTALLATION

A. Furnish and install all cable connectors as shown on the Drawings.

B. Provide number of connectors as required by the Drawings and as required by these documents, where the number of connectors required does not fill the entire faceplate provide blank inserts so that no opening is left.

C. The provision and termination of connectors from each cable shall be done as follows:

1. Where connector types are identified on the applicable drawings or in the specifications, furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
2. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

D. Copper Connector Installation

1. Terminate all four pairs of each cable on one outlet jack.
2. Furnish and install all cable connectors as shown on the Drawings or as indicated herein, unless otherwise noted.

3. The provision and termination of connectors for each cable shall be done as follows:
  - a. Where connector types are identified on the applicable drawings or in the specifications, Furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
  - b. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

### 3.5 FACEPLATE INSTALLATION

- A. Furnish and install all faceplates in locations as shown on the Drawings.

### 3.6 CABLE IDENTIFICATION

- A. Label all horizontal cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.
  1. Shop drawings shall include floor plan that indicates proposed cable/outlet identification for each outlet.
- B. Cables shall be labeled within 6" at each end.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
  1. Brady, IDXPRT
  2. Hellermann Tyton, Spirit 2100
  3. Panduit LS9
  4. Or equivalent

### 3.7 CABLE TERMINATIONS

- A. Terminate all horizontal cables in accordance with Division 27 Section "Communications Equipment Room Fittings". No cables shall contain unterminated elements UON.

### 3.8 CABLE TESTING

- A. Refer to Division 27 Section "Structured Cabling System" for testing requirements.

### 3.9 ACCEPTANCE

- A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.
- B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found.

## END OF SECTION 271500

## **SECTION 274100 - AUDIO VIDEO SYSTEMS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. These specifications and the associated TA series drawings describe the audio-video (AV) systems (hereafter referred to as the "Technical System") requirements to be furnished and installed as a portion of the project scope of work.
- B. System is intended for conference room presentation.
- C. Work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Communications, Fire Alarm and Electronic Safety and Security Drawings and Specifications; and Addenda.
- D. Work under this section of the specifications includes all labor, equipment, and installation as required to provide a complete technical system in compliance with the contract documents.
- E. Employ the services of a qualified structural engineer to review all overhead mounting and suspension details of the technical system equipment. All mounting and suspension schemes indicated on the drawings are shown for concept only. Submit shop drawings stamped by a structural engineer of all details and weights for review by the project's Architect, Structural Engineer, and Design Consultant.
- F. The work in this section shall be coordinated with other work to determine installation scope for conduit, outlet boxes, junction boxes, pull boxes, terminal cabinets, 120-volt AC power circuits, and insulated ground cables required for the technical system.
  - 1. Provide related low-voltage "on/off" AC power control system wiring, low-voltage "on/off" control switches, and certain AC power/ground requirements internal to the equipment racks as specifically noted herein and/or on the drawings.

#### **1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:
  - 1. Division 27 Section "General Communications Requirements"
  - 2. Division 27 Section "Common Work Results for Communications"
- B. All Category cabling and terminations shall adhere to sub-sections in Part 3 of this section for requirements.
- C. This section is a parent section to all sections numbered 274101 thru 274199. Requirements found in this section shall apply to all child sections unless otherwise noted.
  - 1. Exception: Division 27 "Television Distribution Systems" is a stand-alone section.

#### **1.3 EXAMINATION OF SITE**

- A. This project is an existing facility undergoing expansion.
- B. Prior to submitting a bid personally examine the site of the proposed work and verify the conditions which involve this work.
- C. By the act of submitting a bid, the contractor will be deemed to have made reasonable allowances for site examinations, site conditions, and included all costs in their proposal. Failure to verify these conditions will not be considered a basis for the granting of additional compensation.

#### **1.4 MATERIAL AND WORKMANSHIP**

- A. All equipment shall be new and in proper operating condition. All workmanship shall be of the finest quality by experienced installation technicians.

- B. Contact the Architect, in writing, regarding the selection of colors for all exposed equipment.
- C. In addition to a complete set of the system project drawings and specifications, maintain at the job site a complete set of manufacturer's original operation, instruction, installation, and service manuals for each equipment item, for reference.

#### 1.5 ORDINANCE AND CODES

- A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections "General Communications Requirements", follow the most recent editions of the following:
  - 1. NFPA 70 – National Electrical Code (NEC)
  - 2. IEEE National Electrical Safety Code (NESC)
- B. Contractor shall be responsible for any and all violations within the scope of this work.

#### 1.6 DEFINITIONS

- A. Refer to Division 27 Section "Gen" for common requirements.

#### 1.7 QUALITY ASSURANCE

- A. Contractor General Qualifications:
  - 1. Compliance with the requirements of Division 1.
  - 2. Licensed to perform work of this type in the project jurisdiction.
  - 3. At least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein.
  - 4. Prior successful experience of projects of similar size, scope and type as outlined in the Construction Documents.
  - 5. Active membership in the National Systems Contractors Association (NSCA).
  - 6. Active membership in The Audiovisual and Integrated Experience Association (AVIXA).
    - a. AVIXA APEX certification.
  - 7. Fully staffed and equipped maintenance and repair facility.
  - 8. Factory-authorized dealer for the major components specified.
- B. Contractor Personnel Qualifications:
  - 1. Skilled workers thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and the methods needed for proper performance of the work in this section. The workers shall have at least three (3) years direct experience in similar work, evidence of which shall be verified in writing with appropriate references.
  - 2. Supervisor with at least five (5) years direct experience in similar work. The supervisor shall be present for and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To assure continuity, this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene. This person shall act as the Technical System Project manager and shall attend all scheduled project meetings.
    - a. Minimum of one full-time staff member who has attended technical system design and installation courses taught by Syn-Aud-Con in the past 10 years.
    - b. Minimum of one AVIXA CTS-I (Certified Technology Specialist - Installation) systems technician.
- C. Provide additional information as required for review by the Owner's Representative, Architect, and Design Consultant to aid in proving acceptability.

#### 1.8 SUBMITTALS

- A. Refer to requirements in Division 27 Section "General Communications Requirements".
- B. Include the following items specifically as it relates to AV:
  - 1. Submittal #1: AV System Product Data (Pre-Construction). A separate product data submittal is required for each specification section, i.e., 274100, 274116, etc.
    - a. Equipment List (1A)
    - b. Manufacturers' cut sheets (1B)

- c. Product Substitutions (1C)
  - d. Project Implementation Schedule (1D)
- 2. Submittal #2: AV System Shop Drawings (Pre-Construction)
  - a. AV Pathways, Devices, and Cabling (2A) – Follow requirements of Division 27 Section “Common Work Results for Communications”. Indicate locations of all devices and equipment.
  - b. Signal Flow Shop Drawings (2B) – Any generic diagrams found within the Construction Documents shall be drawn to specific requirements. Alterations from basis of design found within the Construction Documents shall be reflected and identified. Include wire numbering scheme.
- 3. Submittal #3: AV System Fabrication Drawings (Pre-Construction)
  - a. Panel, Patch Panel, and Plate Shop Drawings (3C) - All panel, patch panel, and plate layouts indicating locations of connectors, engraving, nomenclature, panel material, and finish. Include Structured Cabling Work required by the technical system.
- 4. Submittal #4: AV System Test Results (Prior to Substantial Completion)
  - a. Preliminary Testing Documentation Package (4A) – Provide preliminary results of system testing as described in Part 3 of this section for review prior to final acceptance. Include final results with Closeout Documentation.
- 5. Project Closeout
  - a. Refer to Division 27 Section “General Communications Requirements” and the Record Drawings and Operation and Maintenance Data sub-sections in Part 3 of this section for requirements.

#### 1.9 SUBSTITUTIONS

- A. Refer to Division 27 Section “General Communications Requirements”.

#### 1.10 ELECTRONIC FILE SHARING

- A. Refer to Division 27 Section “General Communications Requirements” for information on obtaining electronic versions of the construction drawings.

#### 1.11 PROTECTION OF WORK

- A. Protect all work, materials, and equipment from damage due to any cause. Provide for the safety and new condition of the equipment and materials until final acceptance by the Owner's Representative. Replace all damaged or defective materials and/or equipment as directed by the Architect or Design Consultant.
- B. Equipment racks, cabling racks, junction boxes, termination boxes, and other exposed equipment shall be kept covered and protected from airborne contaminants. Clean all debris from the equipment room(s)/location(s) and control areas, and clean all equipment and the interior rack floor, prior to system final acceptance activities.

#### 1.12 TEMPORARY TECHNICAL SYSTEM

- A. Provide and operate a temporary technical system of reasonably equivalent function as determined by the Design Consultant if the work in this section, as a failure of the contractor, is incomplete or found not in conformance with the contract documents. The temporary system shall remain in use until acceptance of the permanent system.

#### 1.13 WARRANTY

- A. Warrant all work executed under this contract, including all in-shop and onsite material, parts, and labor, for a period of twelve months after the date of final acceptance.
  - 1. Existing or any other Owner-furnished equipment shall not be included in this warranty.
  - 2. For equipment that has an advertised manufacturer's warranty longer than 12 months, include end date of warranty period.
- B. For facilities that operate on a repeating annual basis, such as educational and sports facilities, the warranty shall be 15 months.
- C. The warranty services are limited to normal business hours unless additional agreements are made between the Owner's Representative and the contractor.
- D. Warranty work relating to technically complex equipment and/or programming such as for codecs, digital signal processing, control systems, and video projectors shall be performed by a factory authorized technician.

- E. Damage to the system resultant from improper use or adjustment by others, negligence, acts of nature, or other causes which are beyond the contractor's control shall be excluded from the warranty.
- F. Visit the job two weeks prior to the end of the warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.
- G. Update Record Drawings and Operation and Maintenance Data to reflect work done during Warranty period and provide the updates to the Owner's Representative and Design Consultant.
- H. Refer to General Conditions for additional requirements.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Unless otherwise designated, provide all of one type of equipment from one manufacturer. For example, microphones of one type by one manufacturer, data switches of one type by one manufacturer, cabling of one type by one manufacturer, or loudspeakers of one type by one manufacturer.
- B. Equipment and wiring shown on the drawings represents the basis of design. Ensure similar or better performance is achieved by substituted equipment.
- C. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.
- D. All equipment shall be new and of professional quality.
- E. Some items listed in these specifications are custom-made products. Ensure when pricing and ordering equipment that the exact part number called out is used. If there is a discrepancy, contact the Design Consultant for clarification.
- F. The quantities of each item of portable or mobile equipment (and other portable or loose accessories), as well as those items associated with Alternates, are indicated in parenthesis. Such equipment is intended to be shared between rooms having technical systems, except where noted for use in one specific room.

### **2.2 LOUDSPEAKERS – INSTALLED**

- A. General loudspeaker requirements:
  - 1. Loudspeaker, and related mounting bracket(s) where appropriate, color shall be as selected by the Architect from the available color selection offered from each loudspeaker manufacturer.
- B. Sound Bar – Type 1, sound bar, 20 watt, full range, minimum of four low-frequency drivers, minimum of two high-frequency drivers, fix/variable source volume:
  - 1. JBL PSB-1; or
  - 2. Approved equal.

### **2.3 FLAT PANEL DISPLAYS - GENERAL**

- A. Flat panels in this section shall be LCD, by one manufacturer, unless noted otherwise.
- B. All LCD flat panel displays specified in this section shall have the following features or options included, unless noted otherwise:
  - 1. Display response time of 10ms or less
  - 2. LED backlighting
  - 3. VESA mounting compatible
  - 4. Minimum viewing angle of 175° horizontal x 175° vertical
- C. LCD flat panels are listed by series, with the basis of design model shown on the signal flows. The minimum requirements for inputs, outputs, control connections and optional interfaces/accessories shall be as indicated on signal flow diagrams.

- D. Deviation from the basis of design to a proposed substitute will be allowed as follows:
1. All audio, video, and control connections shown on signal flow (connectors shown on equipment block but without any connections are not required for substitution) shall meet or exceed the basis of design with respect to quantity, type, version, and supported protocols. This shall include the standard features of the display as well as any optional interfaces/accessories.
    - a. Example connections include but are not limited to:
      - 1) TV tuner (NTSC, ATSC, and Clear QAM compatible),
      - 2) HDMI (HDCP compatible),
      - 3) DVI-D (HDCP compatible),
      - 4) SDI (SD, HD, 3G, Dual Link, 6G),
      - 5) Displayport (HDCP Compatible),
      - 6) HD15 RGB with 3.5mm audio,
      - 7) Component with stereo audio,
      - 8) Composite with stereo audio,
      - 9) Multi-channel audio,
      - 10) RJ45 LAN,
      - 11) RJ45 HDBaseT,
      - 12) RS232 control via DB9 connector, and
      - 13) USB.
  2. Contractor shall be responsible that the proposed substitute meets or exceeds the basis of design and will:
    - a. have an equivalent aspect ratio.
    - b. meet the capabilities of any built-in speakers.
    - c. physically fit in the location with sufficient space for ventilation and servicing.
    - d. have an equivalent brightness rating and backlighting technology (edge light, direct back light, etc.)
    - e. utilize the same touch sensing technology (resistive, capacitive, etc.)
    - f. be compatible with the display mount.
    - g. allow for multiple mounting orientation capabilities (horizontal, vertical/portrait, etc.).
    - h. have an equivalent manufacturer's warranty.
  3. Contractor shall submit details, including shop drawings where applicable, for each proposed substitute which include information relating to the above.

#### 2.4 DISPLAY – COMMERCIAL LCD FLAT PANEL

- A. LCD flat panels in this section shall be by one manufacturer, unless noted otherwise.
- B. All LCD flat panel displays specified in this section shall have the following features or options included, unless noted otherwise:
1. Display response time of 10ms or less
  2. LED backlighting
  3. VESA mounting compatible
  4. Viewing angle of 175° horizontal x 175° vertical (or greater)
- C. LCD flat panels are listed by series, with the basis of design model shown on the signal flows. The minimum requirements for inputs, outputs, control connections and optional interfaces/accessories shall be as indicated on signal flow diagrams.
- D. Deviation from the basis of design to an approved substitute will be allowed as follows:
1. All audio, video, and control connections shown on signal flow (connectors shown on equipment block but unconnected are not required for substitution) shall meet or exceed the basis of design with respect to quantity, type, version, and supported protocols. This shall include the standard features of the display as well as any optional interfaces/accessories.
    - a. Example connections include but are not limited to TV tuner (NTSC, ATSC, and Clear QAM compatible), HDMI (HDCP compatible), DVI-D (HDCP compatible), SDI (SD, HD, 3G, Dual Link, 6G), Displayport (HDCP Compatible), HD15 RGB with 3.5mm audio, component with stereo audio, composite with stereo audio, multi-channel audio, RJ45 LAN, RJ45 HDBaseT, DB9 for RS232 control, and USB.
  2. Proposed substitute shall have an equivalent aspect ratio.
  3. Proposed substitute shall meet the capabilities of any built-in speakers.
  4. Proposed substitute shall have an equivalent brightness rating and backlighting technology (edge light, direct back light, etc.)
  5. Proposed substitute weight shall be considered with respect to the display mount. It shall be the responsibility of the contractor to confirm the mount is compatible with the substitute display.

6. Proposed substitute mounting orientation capabilities (horizontal, vertical/portrait, etc.) shall meet or exceed basis of design.
  7. Proposed substitute manufacturer's warranty shall meet or exceed the basis of design.
  8. Proposed substitute shall take into account functionality features such as standby/sleep mode, picture-in-picture, video and audio processing capabilities, etc.
- E. Equipment naming convention
1. "Product Type" – "Nominal Diagonal Size (inches)" / "Resolution" – "Accessories"
  2. Example: FPD-52"/UHD-T
    - a. Product Type: FPD
    - b. Nominal Diagonal Screen Size: 52"
    - c. Resolution: UHD (Ultra High Definition)
    - d. Accessories: T (Television Tuner)
- F. Acceptable manufacturers and model series include:
1. FPD-55"/UHD-T
    - a. NEC E\*\*\* series
    - b. LG UR\*\*\* series
    - c. Samsung QMR\*\*\* series

## 2.5 FLAT PANEL DISPLAY/TELEVISION MOUNTS

- A. Unless noted otherwise, provide the appropriate mount for each display furnished. Mount color as selected by Architect. Match mount to the display and the mounting surface.
- B. Full assembly (display, mount, and all associated connections/equipment) shall be adequately supported with the appropriate safety factor to building structure. Appropriate structural backing/support shall be provided. No mounts shall fasten directly to the roof deck. Refer to submittal requirements.
- C. Furnish all components to provide a complete installation, including fastening systems suitable for the mounting surface.
- D. All recessed or built-in displays/televisions require shop drawings showing the surrounding architecture to ensure proper fit and ventilation requirements.
- E. Refer to drawings for anticipated mount type required for each display location.
- F. Provide outdoor rated mount variants in locations as applicable.
- G. Mounts shall be selected and installed to ensure the full display/mount assembly meets all ADA requirements, including Protrusion Limits into Circulation Paths of no more than 4" (as defined by the ADA Accessibility Guidelines). Additional considerations may include:
  1. The use of thin mounts in lieu of standard depth display mounts to reduce mounting depth.
  2. Where wall standoffs are utilized, ensure overall depth is no greater than 4".
  3. The use of "right angle" plugs or terminations may be required to maintain minimum cable bend radius.
  4. The use of recessed back boxes may be required to accommodate plugs or terminations and any display mounted equipment.
  5. The use of recessed back boxes with thin profile articulating mounts may be utilized in lieu of thin mounts.
- H. Flat Panel Mount – Wall – Articulating ADA: articulating arm wall mount that pulls out, rotates, and tilts down, fully adjustable, lockable, sized for display as required; with recessed back box for retain mount within wall cavity, maximum depth of mount at face of wall no greater than 0.5":
  1. Chief RIW Series mount with PAC501B in-wall back box; or
  2. RP Visuals Wallmate Series; or
  3. Approved equal.

## 2.6 CABLES – FACTORY TERMINATED – INSTALLED

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this subsection does not indicate a requirement for use.



- B. Factory terminated cable assemblies specified in this subsection are only permitted for use within racks or between devices external to racks. Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary in this situation. Not permitted for use in conduit unless specifically noted as such.
- C. Factory terminated cable assemblies shall be the minimum length needed to accomplish the connection. Portable cable assemblies are specified in Division 27 Section "Audio Video Systems Equipment" and are required to be furnished in addition to those required for system installation.
- D. All cable assemblies must be factory tested and certified.
- E. Category cabling:
  - 1. Shielded Category 6 horizontal cabling
    - a. Horizontal cables for dry environments
      - 1) Requirements
        - a) Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
        - b) Aluminum Foil Tape Shield (F/UTP)
        - c) Four pairs of 23 AWG copper conductors with drain wire
        - d) Cable jacket color(s) shall be:
          - i) Black
        - e) Cable jacket marking: Shall be legible and shall contain the following information:
          - i) Manufacturer's name
          - ii) Copper Conductor Gauge
          - iii) Pair Count
          - iv) UL and CSA listing
          - v) Manufacturer's trade mark
          - vi) Category rating
          - vii) Sequential distance markings, in one foot increments
        - f) Individually insulated conductors under a common sheath
        - g) Where all cables are to be installed in conduit from outlet box to AV Equipment Rack, cable shall be riser (CMR or MPR) rated. Where any portion of any cable is routed in an air plenum space, cable shall be plenum (CMP) rated.
      - 2) Manufacturer shall be:
        - a) From the following list, subject to Coordination and Warranty requirements:
          - i) Superior Essex CAT 6+ ScTP
          - ii) Belden DataTwist 2400
          - iii) Berk-Tek LANMARK-6 FTP
          - iv) Hitachi Shielded Category 6 Cable
          - v) Hubbell Speedchannel FTP Cable, Category 6
          - vi) Mohawk Category 6 F/UTP
          - vii) Panduit TX6000 Shielded Copper Cable
- F. HDMI Locking Cable, version 1.4 or higher compliant, locking connectors, male HDMI to male HDMI, Acceptable lengths: 1'-25':
  - 1. Belden HD-800 Series (2', 4', 8', 25'); or
  - 2. Clark Wire HDMI-L Series (3', 6', 10', 16'); or
  - 3. Perfect Path 800 Series (2', 4', 8', 16', 25'); or
  - 4. Approved Equal.
- G. Audio Cable – TRS1/8 to TRS1/8 6', three conductor 1/8" male connector to three conductor 1/8" male connector cable, Acceptable lengths: 3'-15':
  - 1. Hosa CMM Series Series (3', 5', 10', 15'); or
  - 2. Comprehensive MPS-MPS-\*ST Series (3', 6', 10', 15'); or
  - 3. Approved equal.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION, GENERAL**

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

### 3.2 PREPARATION

- A. Coordinate locations and sizes of junction boxes, outlets, and conduit with the work of other trades. Field verify compliance with the construction documents.
- B. Carefully inspect areas where equipment will be installed. Notify the Architect of any conditions that would adversely affect the installation and subsequent operation of the system.
  - 1. Repeat inspection on a regular basis to ensure ongoing work by other trades does not pose a conflict to Contractor's pending work.

### 3.3 INSTALLATION

- A. General
  - 1. Contractor shall demonstrate a reasonable standard of care. Installation shall be rendered in a workmanlike manner observing direction set forth herein as well as industry standard best practices.
  - 2. In addition to any spare cabling shown on drawings, utilize industry best practice to pull additional spare cabling in conduit where logical. Neatly bundle a usable length of cable at each end of each spare circuit. All spare circuits shall be labeled and noted on the field drawings for inclusion into the record drawings.
  - 3. Furnish all equipment with factory finish where possible using the standard available factory color(s) as selected by the Architect. Notify the Architect regarding color options of relevant equipment prior to ordering equipment from each manufacturer.
- B. Loudspeakers
  - 1. Install loudspeakers so there are no obstructions to loudspeakers' coverage pattern.
  - 2. Loudspeakers shall be installed such that they do not produce or cause mechanical rattles in the surrounding structure. There shall be no audible vibration or noise caused by improper mechanical installation or defective components.
- C. Video
  - 1. Coordinate structural backing required for wall mounted flat panel displays/televisions prior to the installation of drywall or other wall materials.
- D. Grounding
  - 1. Comply with NEC and BICSI grounding requirements.

### 3.4 CABLEING AND TERMINATION

- A. General
  - 1. Do not violate the minimum cable bend radius as specified by the cable manufacturer.
  - 2. Dress cables so terminations are free from stress due to gravity acting on the cabling.
  - 3. All circuits, including various audio signal levels, shall be separated according to function. Where audio and video circuits are installed in conduit or other raceway, separate conduits are required for the various circuit functions.
  - 4. Where circuits are exposed in the equipment racks or large junction or pull boxes, circuits shall be bundled according to function. Refer to "Conduit/Circuit Group Divisions" and "Conduit Routing and Separation" schedules for additional information.
  - 5. Use Velcro tie wraps (hook and loop) for all category, coaxial, or fiber cables and additionally as practical for other types of cables. Do not use zip ties on any category, coaxial, or fiber cables and limit use where possible otherwise.
  - 6. Do not tighten cable wraps so the cable is deformed. Zip ties should never be used in locations prone to damage due to cable sagging.
- B. Telecommunications Cabling
  - 1. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
    - a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
    - b. No horizontal Category 6 cables shall exceed the allowed maximum distance of 295 feet (90 meters) by TIA-568-C.
  - 2. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system.

- a. All horizontal cables shall be suitable for installation in their environment, either plenum (CMP, MPP, OFNP, or OFCP) or riser (CMR, MPR, OFNR, or OFCR) rated, unless otherwise noted.
    - b. Horizontal cables installed in Wet Locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
  3. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
    - a. Except when supported by ladder racking within each AV Equipment Room/Rack, UON.
  4. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb (90.72 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
  5. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
  6. Comply with all referenced standards and guidelines.
  7. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
  8. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the device (if not in conduit) and one at the equipment room/enclosure. Each slack/service loop shall be:
    - a. A minimum of 8 feet (2.44 meter) in length, UNO
    - b. Configured in a loosely formed figure eight configuration (ie. not coiled)
  9. Use of any cable pulling lubricants is prohibited.
    - a. Where lubricant is deemed necessary by the contractor to facilitate installation of cable in conduit, submit RFI with explanation, effected conduit run, proposed lubricant type, letter from cable manufacturer indicating proposed lubricant will not damage or degrade cable, and a letter from the manufacturer providing the Advanced System Warranty (if applicable) that the use of this lubricant will not exclude that cable run from the required warranty.
- C. Loudspeaker Level Audio
1. Loudspeakers in the same acoustic space shall all be wired to produce consistent polarity with a mono input signal. They shall also be polarized such that a positive acoustic pressure on a microphone results in a positive acoustic pressure at all loudspeakers.
- D. Video
1. Neatly dress all cables behind a flat panel display/television. Cables and connections should not be visible from the viewing locations. Power cables for displays shall not be bundled with signal cables nor visible.

### 3.5 LABELING

- A. Adhere to AVIXA F501.01:2015 "Cable Labeling for Audiovisual Systems" as a minimum standard with additional requirements as described in this paragraph.
- B. Develop and utilize a consistent numbering scheme across the entire project. Utilize system names and building references where applicable, such as the rack number or rack room in a distributed system. All labels for input/output plates and control panels shall be consistent with the final room numbering for the facility.
- C. Document the labeling standard for inclusion in the Operation and Maintenance Data.
- D. Document all labels for the Record Drawings.
- E. Label all cabling with machine-printed labels according to the labeling scheme identified on the drawings. If the drawings do not address labeling scheme, submit RFI through appropriate channels requesting labeling scheme.
  1. Shop drawings shall include floor plan that indicates proposed cable/outlet identification for each outlet.
- F. Cables shall be labeled within 6" at each end.
- G. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
  1. Brady, IDXPART

2. Hellermann Tyton, Spirit 2100
3. Panduit LS9
4. Or Approved Equivalent

### 3.6 SYSTEM CONFIGURATION

- A. Coordination
  1. Coordinate and take responsibility for the approval of all system configuration components as described in this paragraph.
  2. Coordinate all aspects of the technical system network, including configuration and connection with to the Owner's LAN. Utilize Owner's designated configuration style, standards, and security requirements.
- B. Network Configuration
  1. All technical system devices with an Ethernet port shall be connected to the associated network.
  2. Secure the entire network, documenting all passwords. Comply with the Owner's IT representative's requirements with respect to password selection and network security implementation.
- C. Network Documentation
  1. Document the IP and MAC addresses of all IP capable equipment for inclusion with the Operation & Maintenance Manuals.

### 3.7 CONTRACTOR'S TESTING, ADJUSTMENT, AND SUBMITTAL REQUIREMENTS

- A. At the completion of the installation, perform the following tests on the system to ensure proper installation and operation. The technical system shall be fully tested with all equipment on site, installed, connected, and fully operational.
- B. Adhere to ANSI/Infocomm 10:2013 "Audiovisual Systems Performance Verification" as a minimum standard with additional requirements as described in this paragraph.
- C. The Contractor shall submit the results of all tests prior to on-site system review by the Design Consultant. Where available, provide documentation obtained directly from the test equipment. Other acceptable documentation includes screen captures, photos, and spreadsheets.
- D. General
  1. Utilize the technical support services offered by the manufacturers of the various technical system components to ensure optimum performance.
  2. All test equipment used for these tests shall be on site during the system final acceptance activities should verification of submitted measurements be required.
  3. Ensure that all equipment is on the jobsite and fully operational. This includes portable (not installed) items and other loose equipment. Remove all devices from shipping or packaging containers, ready for use, and place in equipment storage cabinet.
  4. The functional tests shall include operational tests of all program source equipment (record and playback), wireless microphone system, mixing console, system inputs and outputs, all patch panel receptacles, intercom system, video routing, video distribution, operational controls, AC power sequencing, operation of software, and all system electronics. Functional tests include examination for hum, buzz, hiss, ghosts, hum bars, oscillation, thumps, unintended reception of other signals such as AM or FM radio, TV, CB, ham radio, cell phones, or any other unwanted signals through the system.
  5. Ensure all inputs and outputs are wired to the appropriate devices per construction documents.
  6. Verify system startup and shutdown operates in the proper sequence.
    - a. System head end components shall be energized at the beginning of the startup sequence in an appropriate order to guarantee proper communication with associated devices.
    - b. Loudspeaker power amplifiers shall be energized at the end of the sequence in order to eliminate unwanted transients being reproduced through system loudspeakers.
    - c. System shutdown sequence shall be in reverse order.
  7. Where a system computer is furnished, load and configure all necessary control software. Examples include but are not limited to the following as applicable: wireless microphone management, amplification management, projector/display management, audio console configuration/control, DSP configuration/management, and active loudspeaker management.
  8. Where audio or video digital signal transport is required, ensure all network setup is complete including the installation and licensing of network management application software.

- E. Required testing equipment
  - 1. Certain systems/subsystems require testing and documentation via approved test equipment.
    - a. Systems requiring testing via approved devices will be identified below.
    - b. Required test devices will be listed in related sections.
    - c. Provide unified testing results of similar systems. Describe testing procedure including all test equipment used.
    - d. Provide original results from testing equipment (as applicable).
  - 2. Failure to submit testing documentation conducted via approved devices will result in delayed final acceptance by the Design Consultant.
  - 3. Contractors unable to provide required test equipment shall employ the services, at their own expense, of a certified subcontractor to assist in testing and documentation.
- F. Audio System
  - 1. Loudspeakers Uniformity of Coverage
    - a. Perform audio system verification per ANSI/AVIXA 1M-2009 for all loudspeakers. Document per guidelines set forth in the standard.
- G. Video System
  - 1. Verify that all video systems utilizing HDMI or DisplayPort cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP, correct color space and bit depth, correct frame rate, HDR signal and metadata as applicable, and audio as applicable. Required test equipment includes:
    - a. Hall Research PGA-VHD; or
      - a. Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
      - b. Murideo Fresco Field Test Suite; or
    - b. Quantum Data QD780C; or
    - c. Purelink HDG 2.0; or
  - 2. Setup and calibrate each visual display using current edition of Spears & Munsil High-Definition Benchmark Disc. Perform calibration with environmental lighting set to level representative of the system while in use. Verify each source and variety of resolutions. For projector/screen combinations, the screen drop shall be set to maximize observation from all seats and the image shall fill the available space on the screen.
  - 3. Calibrate each video image using a repeatable, calibrated system. Provide documentation for each calibrated image. Results shall also become a part of the Operation/maintenance manuals. Required test equipment:
    - d. Datacolor Spyder5ELITE Display Calibration; or
      - a. SpectraCal CalMAN Ultimate software (most recent version) running on Contractor-provided laptop which exceeds the minimum requirements stipulated by SpectraCal.
        - 1) Supported Meters: as recommended by SpectraCal
        - 2) Supported Pattern Sources: as recommended by SpectraCal; or
    - e. X-Rite ColorMunki Display
- H. Adjustment
  - 1. Repair or replace any defects or malfunctions found prior to the commencement of final acceptance activities by the Design Consultant.
- I. Testing Documentation Submittal
  - 1. Document the results of all tests and compile into a complete Testing Documentation submittal with the following items:
    - a. Results of the tests detailed herein; and
    - b. Documentation of changes to the systems as a result of any project Change Order, ASI, field directive, Owner Representative direction or the Testing and Adjustment process. Scans of current field set are acceptable for this submittal; and
    - c. Digital photographs or explanation of reasoning for failed test results due to reasons such as site conditions, constraints, equipment availability, equipment failure, direction required from design team or Owner's Representative, etc.; and
    - d. Written notice to the Design Consultant that the system(s) are ready for final acceptance.
  - 2. Include the final approved Testing Documentation package in the Operation and Maintenance Data package.
  - 3. Modify the Record Drawings to include any changes as a result of the adjustment process.
- J. Contact the Design Consultant should problems or concerns arise during the testing activities.
- K. Transmit the Testing Documentation submittal to the Design Consultant in a timely fashion to allow the Consultant appropriate time for review and comment prior to scheduling of final acceptance. The Consultant cannot visit the site or begin the acceptance phase until the submittal has been approved.

- L. Should the Design Consultant be required to invest time performing some or all of the tests, the Contractor will compensate the Design Consultant for all associated costs.

### 3.8 FINAL ACCEPTANCE

- A. After completion of the system installation and after the preliminary tests and adjustments are complete, the contractor in conjunction with the Design Consultant shall perform on-site acceptance of the technical system. This process will include, but not be limited to the following, as applicable:
  - 1. Random verification of contractor tests
  - 2. System check-out
  - 3. Observation of video system to verify proper image display
- B. Provide the services of the designated supervisor and any other technicians who are familiar with the system. Additional time may be required due to Alternates accepted by the Owner's Representative, or due to Addenda or Change Orders (if any) which modify the scope of work. The supervisor shall provide personal assistance during these activities. This duration does not include time for correcting wiring errors, equipment malfunctions, or problems related to the installation of the technical system. This work could occur at any time day, night, weekends, or holidays without additional claims for expense.
- C. At the completion of the final acceptance period, the Contractor shall compile all system configuration settings (files) with copies as required for inclusion in the O&M Manuals described later in these specifications.
- D. In addition, provide the following: hand and power tools appropriate for the type of installation, ladders, lifts, and/or scaffolding as required to reach all high-mounted devices, spare wire and cable of the types used in the installation, selection of wiring fasteners used in the installation, complete set of the most recent reviewed shop drawings, complete set of all manufacturers' original installation/operation/maintenance manuals, and specific test equipment used during the preliminary testing activities.
- E. After the technical system is operational, the Contractor shall provide verbal instruction to designated Owner's Representative as to proper methods of system operation. Video record the instruction class and provide the recording in a usable digital format to the Owner's Representative.
- F. Provide operational assistance for the first major use of the completed system as directed by the Owner's Representative, including being present for: one prior rehearsal associated with the event (if applicable); a technical check immediately prior to the event; and the event itself.

### 3.9 OPERATION AND MAINTENANCE DATA

- A. At the completion of the project, compile thorough copies of the Operation and Maintenance (O&M) Data per Division 27 Section "General Communications Requirements".
- B. O&M data shall be assembled according to rooms or areas as it relates to the project site. The intent is to allow the Owner's Representative to easily locate information relating to a specific system/room without having to spend an inordinate amount of time searching. Include complete information for each system/room – this may involve duplication of information.
- C. Include ANSI E1.47-2017 (Entertainment Technology – Recommended Guidelines for Entertainment Rigging System Inspections) within the O&M data.
- D. As applicable, save full digital version to the system computer.

### END OF SECTION 274100

## **SECTION 280010 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and to all following sections within Division 28.

#### **1.2 DESCRIPTION OF WORK**

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether 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, supplies, tools, equipment, transportation, and utilities.
- B. Division 28 of these Specifications, and Drawings numbered with prefix TY, generally describe these systems, but the scope of the Electronic Safety & Security Work includes all such Work indicated in the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. Drawings show the materials and their relationship to one another, including sizes, shapes, locations, and connections. Drawings also convey the scope of Work indicating the intended general arrangement of the equipment, fixtures, outlets, and cabling without necessarily showing exact details like elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications, along with the device schedules located on drawing legend sheets, define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

#### **1.3 ABBREVIATIONS**

ADA	Americans with Disabilities Act
AFF	Above Finished Floor
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ETL	Electrical Testing Laboratories, Inc.
FCC	Federal Communications Commission
FM	Factory Mutual
IEEE	Institute of Electrical and Electronic Engineers
LED	Light Emitting Diode
NEC	National Electric Code
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NICET	National Institute for Certification in Engineering Technologies
NRTL	Nationally Recognized Testing Laboratory
OEM	Original Equipment Manufacturer
OFCI	Owner Furnished Contractor Installed
OSHA	Occupational Safety and Health Administration
UL	Underwriters Laboratories
UON	Unless Otherwise Noted

#### **1.4 QUALITY ASSURANCE**

- A. Execute all Work under this Division in a thorough and professional manner by competent and experienced work persons duly trained to perform the Work specified.

- B. Qualifications – refer to individual Division 28 sections for specific Personnel and Contractor Qualifications.
- C. Install all Work in strict conformance with all manufacturers' requirements and recommendations unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation.
- D. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size, and capacity. Provide all material and equipment of the same type from the same manufacturer.
- E. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.
- F. Comply with the current applicable codes, ordinances, and regulations of the authority or authorities having jurisdiction, the rules, regulations, and requirements of the service providers serving the project and the Owner's insurance underwriter.
- G. Drawings, specifications, codes, and standards are minimum requirements. Where requirements differ, the most stringent apply.
- H. Should any change in drawings or specifications be required to comply with governing regulations, notify and receive written approval from the Architect prior to submitting bid.
- I. All equipment and installations shall meet or exceed minimum requirements of ADA, ANSI, ASTM, IEEE, NEC, NEMA, NFPA, OSHA, UL, and the State Fire Marshall.
- J. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workmanlike manner by competent workmen. Provide a competent, experienced, full-time Project Manager who is authorized to make decisions on behalf of the Contractor.
- K. Warranty Requirements
  - 1. Refer to Division 1 and General Conditions for Warranties.
  - 2. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a minimum period of 12 months from date of Substantial Completion, or longer where specific items are required to carry a longer warranty in these Construction Documents or a manufacturer's standard warranty exceeds the minimum. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 1.
  - 3. Refer to individual Division 28 sections for additional warranty requirements, as certain components and systems will have warranty requirements that exceed 12 months.
  - 4. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
  - 5. Schedule repairs with the Owner for times of the day, days of the week as specified by the Owner. No premiums shall be charged to the Owner for work requiring weekend or after "normal business hours" access.
  - 6. Perform the remedial work within 48 hours, upon written notice from the Architect or Owner, unless deferred by the Owner.
  - 7. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

## 1.5 CODES, REFERENCES, AND STANDARDS

- A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes.



- B. Bring all perceived conflicts between codes, ordinances, rules, regulations and these documents to the Architect's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
  - 1. If a conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Architect and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes. Refer to individual sections for exact codes, references, and standards.

#### 1.6 DEFINITIONS:

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
  - 1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
  - 2. Approved - Labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
  - 3. As Directed - As directed by the Architect, or his representative.
  - 4. Concealed - Embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
  - 5. Conditionally Approved – The manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
  - 6. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions.
  - 7. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
  - 8. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division."
  - 9. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
  - 10. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.
  - 11. Provide - "To furnish and install complete, and ready for the intended use."
  - 12. Prime Contractor – a project's overall contractor responsible for all Divisions of Work, usually identified as a General Contractor or Construction Manager At Risk.
  - 13. Submit - Submit to Architect for review.
  - 14. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
    - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
    - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.
  - 15. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
  - 16. Wet Location - A location subject to saturation with water or other liquids. Pathways installed in wet locations do not protect cables from moisture such that cables installed in pathways within wet locations must be identified by their manufacturer for use in wet locations.
    - a. For example: Slab-on-grade construction where pathways are installed underground or in or under concrete slabs that are in direct or indirect contact with soil (e.g., sand and gravel with or without a moisture barrier) is considered a "wet location."

17. (\*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.

- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by, or acceptable to, the Design Consultant as equivalent to the item or manufacturer specified".

#### 1.7 COORDINATION

- A. Coordinate with other Divisions for Electronic Safety and Security work to be included but not listed in Division 28 or indicated on the Security or Fire Alarm Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.
- C. Refer to Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit.
- D. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Division 28 systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.
- E. Execute the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as described in Division 1 and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule to ensure successful achievement of all schedule dates.
- G. Carefully check space requirements with other trades to ensure that equipment can be installed in the spaces allotted.
- H. Refer to Coordination requirements in specific sections for additional information.
- I. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades and report any discrepancies between them to the Architect and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- J. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Architect for review. At completion include a set of these drawings with each set of Record Drawings.
- K. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.
- L. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Architect.

#### 1.8 MEASUREMENTS AND LAYOUTS

- A. The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

## 1.9 SUBMITTALS

- A. Refer to Division 1 and General Conditions for general submittal requirements in addition to requirements specified in this section. Refer to individual Division 28 Sections for additional submittal requirements. Unless otherwise noted, it is acceptable to submit electronic, PDF files.
- B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- C. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- D. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct submittal stages:
  - 1. "Pre-bid" Submittal
    - a. Generally means submittals required no less than two weeks prior to the due date for the submission of bids, such as:
      - 1) Product substitutions, approved alternates, or equivalent requests to be reviewed for approval (Prior to Bid). Coordinate with Division 1.
      - 2) Alternate personnel credentials to be reviewed for approval
  - 2. "Bid" Submittal
    - a. Generally means submittals required at the time of the submission of bids, such as:
      - 1) Unit Pricing (if required by sections in this Division)
      - 2) Personnel Qualifications
      - 3) Contractor Qualifications
  - 3. "Pre-Construction" Submittal
    - a. Generally means submittals required after the award of the project to the winning bidder and prior to starting construction. At a minimum, Pre-Construction submittals shall include:
      - 1) The project name
      - 2) The submitted contractor's company name, the individual's name responsible for the submittal, and contact information for that individual
      - 3) The Prime Contractor's stamp, which shall certify that the stamped submittals have been check by the Prime Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
    - b. Submittals for this division shall be divided and titled in the following manner:
      - 1) Division 28 Electronic Security Systems
      - 2) Division 28 Fire Alarm Systems
    - c. Submit the following items within 4weeks after the notice to proceed:
      - 1) Division of Labor amongst sub-contractors. Include:
        - a) Information on each sub-contractor:
          - i) Company Name
          - ii) Address
          - iii) Name of project manager for this project, including:
            - (1) E-mail
            - (2) Telephone number
        - b) A detailed description or matrix identifying who is responsible for furnishing, installing, and verifying the following system components:
          - i) General requirements:
            - (1) Various system power, backup power, and grounding/bonding items.
            - (2) Various conduit and other common work items.
            - (3) Various low-voltage wires/cabling and terminations.
            - (4) Various structural and seismic items (including design)
          - ii) Individual Division 28 sections
      - 2) Updated Personnel and Contractor Qualifications (resubmit if there are no changes)
      - 3) Schedule - A Gantt chart or Milestone list that includes the following timetables:
        - a) Pre-Construction Submittals
          - i) Include time for resubmittals
          - ii) Unless otherwise stated elsewhere within these specifications, assume 1 week review time for the Prime Contractor and 2 weeks for the Architect/Division 28 Design Consultant for each submittal.
        - b) Material purchase/shipping schedules (to identify any long lead times for critical components)

- c) Conduit Installation
- d) Cabling Installation
- e) Cabling termination and testing
- f) Power and backup power availability
- g) Equipment installation and testing
- h) System startup and configuration
- i) As-built drawings
- j) Operation and Maintenance Manual submission, resubmission, and approval
- k) Final Site Observation for Substantial Completion approval to be at least 2 weeks prior to overall project Substantial Completion date
- l) Owner Training sessions
- m) Other items as required by individual sections in this Division
- 4) Equipment List - A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.
- 5) Data Sheets - Manufacturers' data-sheets:
  - a) At a minimum all product data-sheets shall contain the following:
    - i) The manufacturers' name and logo somewhere on the page
    - ii) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.
    - iii) For data-sheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.
    - iv) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
  - b) Data-sheets are to be in the same sequential order as is presented within the specifications.
- 6) Warranty Information – For warranties required by this specification and other Related Sections, submit warranty terms and conditions for each system or product. These shall contain the following:
  - a) Length of warranty period
  - b) What is covered
  - c) All disclaimers, limitations, etc.
  - d) Anything not covered
- 7) Samples – refer to individual sections for exact sample requirements.
  - a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer is to cover return shipping if sample is to be returned.
- 8) Shop Drawings – Refer to individual sections for exact Shop Drawing requirements.
- d. And as required by individual sections in this Division
- 4. "Project Completion" Submittal
  - a. Generally means, unless otherwise noted, submittals required to be submitted 4 weeks prior to Substantial Completion, for the Design Consultant to reference during the "Final Punch" Site Observation. Project Completion, aka "Close-out Documents" include the following:
    - 1) Record Drawings
    - 2) Operation and Maintenance Manuals – refer to "Operations and Maintenance Data" section below.
    - 3) Owner training syllabus
    - 4) Recorded Owner Training
    - 5) Project test reports
    - 6) Cable Databases (as applicable)
    - 7) Warranty Certificate(s)
    - 8) And as required by individual sections within this Division

E. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Design Consultant that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Design Consultant's designated representatives. Contractor shall allow the Design Consultant review

time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

- F. Identify each sheet of printed submittal pages (using arrows, highlighting, underlining, or circling) to show applicable sizes, types, model numbers, ratings, capacities, and proposed options. Cross out or line-through non-applicable information. Note specified features such as materials or paint finish.
- G. Provide submittals in sufficient detail to demonstrate compliance with these Contract Documents and the design concept.
- H. Transmit submittals as early as required to support the project schedule. Allow two weeks Design Consultant review time, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before construction starts.
- I. No part of the work shall be started in the shop or in the field until the shop drawings and /or samples for that portion of the work have been submitted and accepted.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is compatible with and suitable for the intended use. Verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superseded in any way by the review of shop drawings, product data and samples.
- L. Submittals shall contain the following information. Submittals not so identified will be returned to the Contractor without action:
  - 1. The project name
  - 2. The applicable Specification Section
  - 3. The submittal date
  - 4. The submitting contractor's company name and the project manager's name and contact information.
- M. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
- N. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping, and service connection data.
- O. The Design Consultant's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Design Consultant's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.
- P. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.
- Q. Maintain a complete set of reviewed and stamped shop drawings and product data on site.
- R. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.

## 1.10 ELECTRONIC DRAWING FILES

### A. AutoCAD

1. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

## 1.11 SUBSTITUTIONS

- A. Refer to Bid documents, General and Supplementary Conditions and Division 01 Specification Sections for limitations and restrictions on substitutions in addition to requirements specified in this section.
- B. For products, materials, equipment, or systems for which this Division specifically identifies, the Contractor shall use it as the basis for their bid. However, if the Contractor feels a substitute is appropriate for consideration they may submit, as required in these documents prior to bid, for approval by the Design Consultant.
- C. Materials, products, and equipment described in the Bidding Documents establish a standard of required function, performance, dimension, appearance, and quality to be met by the proposed substitution.
- D. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- E. Request for Substitution:
  1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
  2. The burden of proof of the merit of the proposed substitution is upon the proposer.
  3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
    - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
    - d. Same warranty will be furnished for proposed substitution as for specified Work.
    - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    - f. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.
- F. Substitution Consideration:
  1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
  2. No substitutions will be considered with receipt of Bids, unless the Architect and Design Consultant have received from the Bidder a written request for approval to bid a substitution at least ten calendar days prior to the date for receipt of Bids and have approved the substitution request.
  3. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work of related trades are not permitted.
  4. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner, including verbal. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials which meet the performance as stated or implied in the Contract Documents.
  5. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

## 1.12 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Data.

- B. Prior to Substantial Completion of the project, furnish to the Architect, for Design Consultant's review, and for the Owner's use, the following Division 28 items:
  - 1. An electronic PDF file containing:
    - a. A parts list of all equipment installed
    - b. Equipment data-sheets for all equipment installed,
    - c. Summary of all settings and configurations for each piece of installed equipment
    - d. Listing of all software and versions install
    - e. All software licensing information
    - f. Record Drawings completed in electronic format, updated from submitted Shop Drawings,
    - g. Manufacturer's service and maintenance data,
    - h. Warranty certificates
    - i. Include local contacts complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Refer to individual sections in this Division for additional requirements.

#### 1.13 APPROVED EQUIVALENTS

- A. For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.

#### 1.14 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division.
- B. Obtain the Owner's or Owner's representative's written acceptance when the specified spare parts for that section are delivered.

#### 1.15 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified in this section.
- B. Maintain current-to-the-day set of jobsite work prints of the Issued for Construction Drawings, reflecting an accurate dimensional record of deviations between work shown on Drawings and that installed.
  - 1. Record dimensions clearly and accurately to delineate the work as installed; suitably identify locations of all equipment by at least two dimensions to permanent structures.
  - 2. Pay particular attention to those items that require locating for servicing. This includes, but is not limited to, above-ceiling items such as:
    - a. Cable and conduit routing
    - b. Pullbox and junction box locations
- C. At the completion of the project, obtain reproducible electronic copies of the final Drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done electronically in Adobe or Bluebeam PDF and saved to PDF format. Mark each sheet "Record Drawing", along with the date, and deliver these Record Drawings to the Architect.
  - 1. PDF versions of the drawings shall have searchable text. "Flattened" PDFs will not be acceptable.

#### 1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect and Design Consultant.
- D. Be responsible for the safe storage of tools, material, and equipment.

#### 1.17 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings:
  - 1. The Drawings describe the general nature of remodeling to the existing building; however, visit the Site prior to submitting bid to determine the nature and extent of work involved.
  - 2. Schedule Work in the existing building with the Owner.
  - 3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves security systems, equipment, raceways, equipment supports or foundations and materials.
  - 4. Remove articles that are not required for the new Work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state, and local regulations.
  - 5. Relocate and reconnect security facilities that shall be relocated to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where security equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
  - 6. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
  - 7. Protect adjacent materials indicated to remain. For Work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
  - 8. Locate, identify, and protect services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services shall be interrupted, provide temporary services for affected areas.
- B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- C. Use of explosives is not permitted.
- D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

### **PART 2 - PRODUCTS**

#### 2.1 EQUIPMENT AND MATERIALS

- A. Use only products listed for their intended use by a NRTL, except products for which no relevant standards exist.
- B. Where products are required to be NRTL listed, classified, approved or otherwise each individual item shall bear the NRTL mark by permanent means.
- C. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.
- D. Products and materials shall not contain asbestos, PCB, or any other material, which is considered hazardous by the Department of Environmental Protection or any other authority having jurisdiction.
- E. As directed by the Architect, replace materials of less than specified quality and relocate work incorrectly installed.
- F. Refer to individual sections for labeling requirements.
- G. Install materials and equipment with qualified trade people.



- H. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.
- I. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.
- J. Where factory testing of equipment is required to ascertain performance and attendance by the Owner's representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.
- K. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be de-rated with the method of de-rating identified on the submittals.
- L. Enclosures for Electronic Safety and Security Infrastructure/equipment installed in mechanical equipment rooms shall be NEMA type 1 gasketed. Enclosures for Electronic Safety and Security Infrastructure/equipment installed outdoors shall be NEMA type 3R.
- M. If products and materials are specified or indicated on the drawings for a specific item or system, use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, subject to approval of product data submittal.
- N. Ship and store all products and materials in a manner that will protect them from damage, weather, and entry of debris. If items are damaged, do not install, but take immediate steps to obtain a replacement. Repairs of damaged goods will only be permitted with prior written permission of the Owner/Design Consultant.
- O. Part numbers and product codes in these specifications are correct as of the time of writing. Manufacturers may, however, change part numbers and product codes on short notice. In cases where part numbers or product codes differ from technical specifications for a particular product, provide products meeting the minimum technical specifications of the products in the specifications. Notify the Owner/Design Consultant of any product code and or part number changes on the material list submittal.

### **PART 3 - EXECUTION**

#### **3.1 FEES AND PERMITS**

- A. Secure and Pay all required fees and obtain all required permits related to the Electronic Safety and Security Systems' installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.

#### **3.2 SELECTIVE DEMOLITION**

- A. Refer to Division 1, Division 2, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. Examine the site to observe existing conditions before submitting a bid.
- C. General: Demolish, remove, demount, and disconnect abandoned communications materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- D. Schedule demolition in advance. Schedule work to avoid disruption of normal operations.
- E. Materials and Equipment to Be Salvaged:
  - 1. Electronic Safety and Security infrastructure and equipment to be removed that is in good working order shall be carefully removed and offered to the Owner. Items rejected by the Owner shall be removed from the project site and legally and properly disposed of.
  - 2. Remove, demount, and disconnect existing communications materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

- F. Reconnect circuits serving equipment required to remain in service to other cable termination fields, patch panels or splices as indicated on the Drawings or as appropriate. Provide additional cable and termination hardware where there is insufficient available capacity in remaining existing equipment for reconnection.
- G. Remove existing conduit and wire back to the Electronic Safety and Security Equipment unless a specific extent of removal is indicated on the Drawings.
- H. Electronic Safety and Security Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
  - 1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
    - a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
    - b. Perform cutting and patching required for demolition in accordance with Division 1, General Conditions and "Cutting and Patching" portion of this Section in Division 28.

### 3.3 EXISTING CONDITIONS

- A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.
- B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

### 3.4 EXISTING SERVICES

- A. Existing Electronic Safety and Security Infrastructure services not specifically indicated to be removed or altered shall remain as they presently exist.
- B. Where existing services interfere with new construction, alter, or reroute such existing equipment to facilitate new construction after obtaining written permission from the Architect. Notify in writing giving two weeks advance notice or planned alteration prior to altering any existing condition is required.
- C. Schedule and coordinate with the Owner and with the Architect all connections to, relocation of, or discontinuation of normal services from any existing service provider line. Include all premium time required for all such work in the Bid.
- D. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.
- E. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or Utility Company without additional cost.
- F. Do not leave services disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Architect.
- G. Make repairs and restoration of services before workmen leave the project at the end of the workday in which the interruption takes place.
- H. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

### 3.5 EXAMINATION OF SITE

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical, electrical, communications, and Electronic Safety and Security installations above or

below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

### 3.6 WORK IN EXISTING FACILITIES

- A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of Work involved.
- B. Schedule Work in the existing facility with the Owner.
- C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves Communications systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.
- D. Remove all articles which are not required for the new Work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.
- E. Channel walls and floors as required to produce the desired result; however, obtain permission from the Architect or Owner for all channeling not specifically noted on the Drawings.

### 3.7 CLEANING

- A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.
- B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.
- C. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.
- D. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- E. Touch up and restore damaged finishes to their original condition.
- F. All Electronic Safety and Security infrastructure and equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation by the Architect as required.

### 3.8 DELIVERY, DRAYAGE AND HAULING

- A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required and provide proper storage and protection until the time it is required. Pay for all costs of demurrage or storage.
- B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, then Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc. at no additional cost to the Owner.

### 3.9 EQUIPMENT AND MATERIAL PROTECTION

- A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the Owner.
- B. Take responsibility for work, materials, and equipment until finally inspected, tested, and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment to moisture damage in dry, heated spaces.

- C. Provide adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

### 3.10 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align, and test all Electronic Safety and Security infrastructure and equipment furnished and/or installed under this Division.
- B. Check and test protective devices for specified and required application and adjust as required.
- C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- D. Notify the Architect immediately of all operational failures caused by defective material, labor, or both.
- E. Refer to individual Sections for additional and specific requirements.

### 3.11 START-UP OF SYSTEMS

- A. Prior to start-up of Electronic Safety and Security systems, check all components and devices, to confirm compliance with manufacturers' recommended installation procedures.
- B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- C. Refer to individual Sections for additional and specific requirements.

### 3.12 OPERATING INSTRUCTIONS

- A. Instruct Owner's operating and maintenance personnel in proper starting sequences, operation, shutdown, general maintenance, and preventative maintenance procedures, including normal and emergency procedures.
- B. Refer to individual Sections for additional and specific requirements.

### 3.13 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
  - 1. Submit complete Operation and Maintenance Data.
  - 2. Submit complete Record Drawings.
  - 3. Perform all required training of Owner's personnel.
  - 4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
  - 5. Perform start-up tests of all systems.
  - 6. Remove all temporary facilities from the site.
  - 7. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.
- B. Request in writing a review for Substantial Completion. Give the Architect at least seven (7) days' notice prior to the review.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.

- F. Upon completion of the review, the Architect and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

#### 3.14 EARLY OCCUPANCY

- A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.
  - 1. Refer to individual sections for additional requirements.
- B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

#### **END OF SECTION**

## SUBSTITUTION REQUEST FORM

To Project Engineer: \_\_\_\_\_ Request # (GC Determined): \_\_\_\_\_

Project Name: \_\_\_\_\_

Project No/Phase: \_\_\_\_\_ Date: \_\_\_\_\_

Specification Title: \_\_\_\_\_

Section Number: \_\_\_\_\_ Page: \_\_\_\_\_ Article/Paragraph: \_\_\_\_\_

Proposed Substitution: \_\_\_\_\_

Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_

Address: \_\_\_\_\_ Phone: \_\_\_\_\_

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: \_\_\_\_\_

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples  
☐ Tests ☐ Reports ☐ Other: \_\_\_\_\_

Reason for not providing specified item: \_\_\_\_\_

Similar Installation:

Project: \_\_\_\_\_ Architect: \_\_\_\_\_

Address: \_\_\_\_\_ Owner: \_\_\_\_\_

Date Installed: \_\_\_\_\_

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: \_\_\_\_\_

**Substitution Certification Statement:**

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
--------------------------------	---------------	------------------

**Manufacturer's Certification of Equal Quality:**

I \_\_\_\_\_ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
--	---------------	------------------

**Engineer Review and Recommendation Section**

Recommend Acceptance      ☐ Yes      ☐ No  
Additional Comments:      ☐ Attached      ☐ None

**Acceptance Section:**

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

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## **SECTION 280501 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. This Section includes general construction materials and methods, electronic security equipment coordination, and common Electronic Security Systems installation requirements as follows:
  - 1. Pathways
    - a. Conduit
    - b. Outlet Boxes
    - c. Pull Boxes
  - 2. Grounding and Bonding
  - 3. Firestopping Systems
  - 4. Access Panels
  - 5. Identification

#### **1.2 RELATED SECTIONS**

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Division 28 Section "General Electronic Safety and Security Requirements"
- B. Firestopping requirements listed in this section are unique to Division 28 Work. Refer to Division 07 Section "Penetration Firestopping" for general and additional firestopping requirements.
- C. Refer to Division 26 for materials and methods for additional requirements for the following:
  - 1. Division 26 Section "Common Work Results for Electrical" for electrical systems coordination.
  - 2. Division 26 Section "Equipment Wiring Systems" for electrical systems coordination.
  - 3. Division 26 Section "Grounding and Bonding for electrical systems" for electrical systems coordination.
  - 4. Division 26 Section "Hangers and Supports for Electrical Systems" for electrical systems coordination.
  - 5. Division 26 Section "Raceways and Boxes for Electrical System" for electrical systems coordination.
  - 6. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for electrical systems coordination.

#### **1.3 CODES, STANDARDS, AND GUIDELINES**

- A. Follow all applicable codes, references, and standards listed in Division 28 Section "General Electronic Safety and Security Requirements".
- B. Follow all guidelines listed in Division 28 Section "General Electronic Safety and Security Requirements".
- C. Follow the correct revision or printing (UON) of all applicable codes, references, standards, and guidelines.
- D. Follow the additional codes, references, standards, and guidelines:
  - 1. Follow the additional codes, references, standards, and guidelines:
    - a. For Telecommunications Infrastructure (Category 5e/6/6A and fiber optic cabling) required by this division:
      - 1) ANSI/TIA/EIA-569-C – "Commercial Building Standard for Telecommunications Pathways and Spaces"
    - b. For Firestopping installed by this division:
      - 1) ASTM E 814 and ANSI/UL1479 – "Fire Tests Through Penetration Firestops"
      - 2) ASTM E 84 and ANSI/UL 723 "Surface Burning Characteristics of Building Materials"
      - 3) ASTM E 119 and ANSI/UL 263 "Fire Tests of Building Construction Materials"

#### **1.4 QUALITY ASSURANCE**

- A. Install all Work in strict conformance with all manufacturers' requirements and recommendations unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- B. Firestopping Systems

1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:
  - a. FM Research approved in accordance with FM AS 4991.
  - b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

## 1.5 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Section "General Electronic Safety and Security Requirements".
- B. The following submittals are due as part of the Pre-Bid Submittal:
  1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information. Be prepared to submit a sample should the Design Consultant request an evaluation.
- C. The following submittals are due at the Pre-Construction Submittal:
  1. Contractor Qualifications (for Firestopping Systems): Provide copies of training/certification as required in the Quality Assurance portion of this specification section.
  2. Parts List: Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
  3. Submit manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:
    - a. Cut sheets shall include the following information at a minimum:
      - 1) Manufacturers name and logo
      - 2) Size – including physical and loading dimensions
      - 3) Maximum span length
      - 4) Weight supported
      - 5) Type
      - 6) Fittings to be used
      - 7) Method of attachment to structure
      - 8) Firestop system assembly information for each system to be installed:
        - a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
          - i) Firestop manufacturer
          - ii) UL system number
          - iii) F, T, and L Ratings
          - iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.
  4. Shop Drawings:
    - a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.
      - 1) Each pathway shall be identified by type and size on the drawings.
        - a) Example #1: 4" EMT
        - b) Example #2: 2" IMC
      - 2) Each grounding conductor shall be identified by size (and insulation):
        - a) Example: #3/0 insulated ground
      - 3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that location.
        - a) Example #1 – Firestopping Sleeve: EZ-Path Series 22, UL System W-L-3255
        - b) Example #2 – Backbox in Fire-Rated Wall: Specseal Power Shield, UL System QCSN/CLIV.R14288
      - 4) Each pull box and access panel shall be identified by size and height above finished floor.
        - a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.
    - b. Include pathway systems (conduit, cable tray, auxiliary supports, etc.) and other common work on the same shop drawings for Division 28 "Electronic Security Systems".
      - 1) The following submittals are due at the Project Completion Submittal:

- a) Record Drawings:
  - i) Based on the work prints kept on the jobsite and official changes to the Contract Documents (such as Change Orders, Architect's Supplemental Instructions, and Design Change Directives), create final drawings incorporating any minor and approved changes to the submitted Shop Drawings. Submit this set in accordance with the Record Drawings requirements of Division 28 Section "General Electronic Safety and Security Requirements".
- b) Keys – Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

## 1.6 DEFINITIONS

- A. Conditionally Approved - the manufacturer has been found reputable by the Design Consultant, but the Design Consultant has not verified that the product offering by manufacturer meets to all specification and project requirements. Contractor shall adhere to submittal review process for final approval on products.
- B. Conveniently Accessible – Capable of being reached from the floor or via the use of a 6 to 12 foot ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.
- C. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.
- D. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- E. IMC – Intermediate Metal Conduit
- F. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
- G. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.
- H. RMC – Rigid Metal Conduit
- I. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- J. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- K. UL – Underwriters Laboratory

## 1.7 COORDINATION

- A. Coordinate arrangement, mounting, and support of 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, ducts, and other systems installed at required slopes and/or elevations.
  - 4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
  - 5. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
    - a. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
    - b. Provide offsets, transitions, and changes in direction of conduit\* as required to maintain proper headroom and pitch on sloping lines. \*Refer to Part 3 of this section for stringent conduit bend requirements.

- 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 Division 28 equipment that are behind finished surfaces or otherwise concealed.
- D. Coordinate testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

## 1.8 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The list below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants or sleeves.
  - 1. Stage
  - 2. A/V Spaces
  - 3. Conference Rooms

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 PATHWAYS FOR ELECTRONIC SECURITY SYSTEMS

- A. General
  - 1. Category 6 and fiber cabling and pathways between Equipment Rooms (shared Communications Rooms) and devices are by Division 27.
  - 2. All other cabling serving Electronic Security System devices within the footprint of the building shall meet the following requirements (from device to Equipment Room):
    - a. Within concealed conduit from device to overhead ceiling space.
    - b. For areas above accessible ceilings, supported via J-hooks every 48"-60" back to nearest cable tray or serving Equipment Room. For inaccessible ceilings or ceilings exposed to structure, continue routing cable within conduit.
  - 3. Division 28 "Electronic Security Systems" Contractor is to indicate proposed pathway types/supports and routing on Division 281000 Shop Drawings.
- B. Conduit
  - 1. Specifications
    - a. Refer to Electrical Division 26 for specific product and material information.
      - 1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
    - b. Conduits routed within the building as connection to outside devices (exterior to the footprint of the building) shall be rigid metal (RMC) or intermediate metal conduit (IMC) at the point it enters the building, emerges from an exterior wall or ground floor slab to the final Equipment Room termination/transition point.
      - 1) If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated.
    - c. For interior devices (and devices on the face of exterior walls) Electrical metallic tubing (EMT) with compression connectors shall be used where concealed in walls, above ceiling, and exposed or concealed in equipment rooms.
    - d. Unless specifically identified on the Security drawings, flexible conduit shall not be used.
    - e. Conduits shall be dedicated to specific sub-systems (i.e. video cabling shall not be installed in any other sub-system conduit, such as access control, intrusion detection, fire alarm, etc.).
    - f. Provide conduit as indicated on the Drawings or required by this Specification.
      - 1) Minimum conduit size for all Category 6 cabling shall be: ¾" inch for interior locations and 1" for exterior locations (such as devices at light poles and gates).
      - 2) Provide a polypropylene or monofilament plastic line with not less than 200-lb tensile strength in each conduit.
      - 3) Permanently mark or tag each conduit at the source and inside each pull box, identifying it based on specific subsystem (Access Control, Intrusion Detection, etc) and far-end destination.

Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.

C. Outlet Boxes

1. The following manufacturers are Conditionally Approved, unless otherwise noted.
  - a. Emerson/Appleton
  - b. Hubbell/RACO
  - c. Randl Industries
  - d. Thomas & Betts/Steel City
  - e. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
2. Specifications
  - a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
  - b. For masonry (CMU) walls, backbox shall be 3-1/2 inches deep. Manufacturer shall be:
    - 1) Single gang – RACO 695R, no substitutes
    - 2) Double gang – RACO 696R, no substitutes
  - c. For stud walls, backbox shall be 2-3/4 inches deep. Manufacturer shall be:
    - 1) Single gang – RACO 560 series, or equivalent from Conditionally approved manufacturer.
  - d. Telecommunications Boxes for Security – for camera outlets shown on TY drawings:
    - 1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches width by 4-11/16 inches height by 2-1/8 inches depth, with a dual-gang or single-gang raised cover/extension as needed for flush mounting. Depth shall match that of wall gypsum board(s).
      - a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings), RANDL T-55017 or equivalent with appropriate
    - 2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches width by 4 inches height by 2-1/8 inches depth, with a dual-gang or single-gang raised cover/extension ring as needed for flush mounting. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).
      - a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.
  - e. Junction Box – in accessible ceiling space above access controlled doors
    - 1) Minimum Size 6” x 6” x 4” deep, or as noted on drawings/details, with hinged cover
    - 2) NEMA 1 rating
    - 3) Manufacturer shall be Hoffman A6N64 (or larger) or equivalent from Conditionally approved manufacturer.
  - f. Pull Boxes - for interior use only, mounted in Conveniently Accessible Locations.
    - 1) Specifications
      - a) NEMA 1
      - b) Refer to Execution section for sizing requirements.
      - c) Shall be keyed
    - 2) The following manufacturers are Conditionally Approved.
      - a) Hoffman
      - b) NEMA Enclosures
      - c) Wiegmann
      - d) Or Equivalent

2.2 FIRESTOPPING SYSTEMS

A. General

1. The following manufacturers are Conditionally Approved.
  - a. 3M
  - b. Hilti
  - c. Specified Technologies, Inc
2. Division 28 “Electronic Security Systems” Contractor is to indicate proposed Firestopping locations that correspond to their proposed pathway and cable routing on Division 281000 Shop Drawings.
3. Refer to Architecture / Life Safety plans for locations of fire- and smoke-rated walls.

B. Zero-Maintenance Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)

1. Specifications
  - a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.

- b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
    - c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
    - d. Allows the installation and removal of cables without the need to remove or add any materials.
    - e. Used to seal penetrations of cables through fire rated partitions
  - 2. Manufacturer shall be:
    - a. EZ-Path family of products by Specified Technologies Inc.
    - b. SpeedSleeve series of products by Hilti
    - c. Or approved equivalent
- C. Firestopping for Backboxes in Fire-Rated Walls
- 1. Specifications
    - a. Used to seal backboxes in fire rated partitions.
    - b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
    - c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
  - 2. Manufacturer shall be:
    - a. Specified Technologies Inc., SpecSeal Power Shield
    - b. Or approved equivalent
- D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications
- 1. For fire-rated penetrations where the pathway extends beyond a single fire-rated partition, and other required firestopping applications not previously addressed in this specification.
  - 2. Specifications:
    - a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.
  - 3. Manufacturer shall be:
    - a. Specified Technologies Inc.
    - b. Or approved equivalent

## 2.3 ACCESS PANELS

- A. The following manufacturers are Conditionally Approved.
- |  |  |
|--|--|
| 1. Activar/J.L. Industries   | <a href="http://www.activarcpg.com">www.activarcpg.com</a>                           |
| 2. Acudor Products   | <a href="http://www.acudor.com">www.acudor.com</a>                                   |
| 3. Alfab/Barco   | <a href="http://www.alfabinc.com">www.alfabinc.com</a>                               |
| 4. Elmdor Products   | <a href="http://www.elmdorproducts.com">www.elmdorproducts.com</a>                   |
| 5. Karp Associates, Inc.   | <a href="http://www.karpinc.com">www.karpinc.com</a>                                 |
| 6. Milcor  | <a href="http://www.commercialproductsgroup.com">www.commercialproductsgroup.com</a> |
| 7. Nystrom Building Products   | <a href="http://www.nystrom.com">www.nystrom.com</a>                                 |
| 8. Williams Brothers   | <a href="http://www.wbdoors.com">www.wbdoors.com</a>                                 |
| 9. Wind-lock   | <a href="http://www.wind-lock.com">www.wind-lock.com</a>                             |
| 10. Or Approved Substitution (submitted and accepted in the "pre-bid" phase) |  |
- B. Specifications:
- 1. To be utilized for access to a Pull Box that is installed above an inaccessible ceiling (where a Pull Box is required to keep the number of bends in conduit to 180 degrees or less between pull points).
  - 2. Steel Access Panels and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
  - 3. Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
  - 4. Frames: 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:
    - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
    - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
    - c. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
  - 5. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
  - 6. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

- C. Locking Devices:
  - 1. Wherever located in a publicly accessible space and are less than 9' AFF, provide a lock.
  - 2. Lock shall be 5-pin or 5-disc type cylinder locks, individually keyed.
  - 3. Provide 2 keys.
- D. **\*Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval. \***

## 2.4 FASTENINGS

- A. Except in equipment rooms, all exposed securing screws shall be stainless steel, center pin torx security screws. Security Fasteners: A maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Holo-Krome; a Danaher Corporation.
  - 2. Safety Socket Screw Corporation.
  - 3. Tamper-Pruf Screws, Inc.
  - 4. Textron Inc.

## 2.5 IDENTIFICATION FOR COMMON WORK FOR ELECTRONIC SECURITY SYSTEMS

- A. Labels
  - 1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.
 

a. Brady	<a href="http://www.bradycorp.com">www.bradycorp.com</a>
b. Brother	<a href="http://www.brother-usa.com">www.brother-usa.com</a>
c. Dymo	<a href="http://www.dymo.com">www.dymo.com</a>
d. HellermannTyton	<a href="http://www.hellermannntyton.com">www.hellermannntyton.com</a>
e. Panduit	<a href="http://www.panduit.com">www.panduit.com</a>
f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)	
  - 2. Specifications:
    - a. Refer to additional requirements in Part 3 – Execution.
    - b. Refer to individual sections for additional identification requirements for specific work.

## **PART 3 - EXECUTION**

### 3.1 PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

- A. General
  - 1. Refer to Electrical Division 26 for specific installation requirements.
    - a. Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
  - 2. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
  - 3. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
  - 4. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb. (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
  - 5. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
  - 6. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.
  - 7. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
  - 8. Store and keep dry all products in original container in a climate controlled environment until installation is to occur
  - 9. Install all pathways:
    - a. So that cables can be pulled in accordance with referenced standards and guidelines.
    - b. So that cables can be pulled without damage to conductors, shield, armor, or jacket.
    - c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
    - d. So that the maximum allowable pulling tension is not exceeded.

- e. To meet the requirements of the structure and the requirements of all other Work on the Project
  - f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
  - g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
  - h. Parallel or perpendicular to building lines or column lines.
  - i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
10. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall not be used to attach cables to cable supports.
11. Provide adequate pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for. Any deviation from this will not be accepted.
- a. At no point shall cables contact, be supported by, or attach to other trades equipment or supports.
  - b. At no point shall cables contact, be supported by, or attach to building structures or supports.
12. Provide appropriately sized sleeves where cables (supported by J-hooks) are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches beyond the partition surface on both sides and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 40% of the cross-sectional area is utilized by the cabling to be installed.
13. Suspended cables shall be installed with at least 3 inches of clear vertical space above the ceiling tiles and support channels (T-bars).
14. Waterproofing
- a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
  - b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.
15. Cutting and Patching
- a. Where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
  - b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
  - c. Patch around all openings to match adjacent construction.
  - d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
  - e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
  - f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.
16. Mounting Heights
- a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.
  - b. Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.
  - c. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
  - d. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.
17. Painting
- a. Refer to Division 9 Section "Painting" for painting requirements.
  - b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
    - 1) If painting happens after cabling has been installed, cabling shall be masked off or otherwise protected so that cables are not painted. Paint on cables degrades the cable over time. PAINTED CABLES SHALL BE REPLACED with no additional cost to the owner.



- c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
  - d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
  - e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
  - f. Provide touch-up paint as required by Specification Sections in this Division.
18. Fastenings
- a. Fasten equipment to building structure in accordance with the best industry practice.
  - b. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.
  - c. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
    - 1) To Wood: Fasten with lag screws or through bolts.
    - 2) To New Concrete: Bolt to concrete inserts.
    - 3) To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    - 4) To Existing Concrete: Expansion anchor fasteners.
    - 5) To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
    - 6) To Light Steel: Sheet metal screws.
    - 7) Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
  - d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with, and obtain the approval of Architect and conform to the following as a minimum:
    - 1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
  - e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
  - f. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces.
- B. Access to pathways and associated equipment
- 1. Locate all pull boxes, junction boxes and fire-rated pathway devices to provide easy access for operation, service inspection and maintenance.
  - 2. Provide an access door/panel where equipment or devices are located above inaccessible ceilings. Where access doors/panels are necessary but not shown on the plans, coordinate type and location with Architect and Design Consultant through an RFI.
  - 3. Maintain all code required clearances and clearances required by manufacturers.
- C. Cable Distribution
- 1. For low-voltage cabling (that provides power at 70v or less), refer to section 2.1 above.
- D. Conduits
- 1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
  - 2. Adequate access shall be available where cables enter conduits
  - 3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements (ANSI STD-607 – "Commercial Building Grounding (Earthing) and Bonding Requirements For Telecommunications).
  - 4. Install conduits in the most direct route possible, running parallel to building lines
  - 5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
  - 6. Conduits which enter Telecommunications or Security/Equipment rooms shall extend 3 inches AFF or through the wall.
  - 7. Flexible conduits may only be used where specifically allowed by these contract documents.
    - a. Where indicated, flexible conduit sections shall be less than 20 feet in length.

8. No continuous section of a conduit may exceed 100 feet without a Pull Box.
9. No more than (2) 90° bends, or equivalent will be allowed between Pull Boxes.
  - a. Each and any offset shall be considered a 90° bend.
  - b. A Pull Box is required wherever a reverse bend is installed.
10. The minimum bend radius for conduits is:
  - a. (6) times the inside diameter for 2 inches conduits or less.
  - b. (10) times the inside diameter for conduits greater than 2 inches.
11. Conduits shall contain no electrical condulets (also known as LBs).
12. Underground Conduit Requirements
  - a. Cabling and pathways serving devices exterior to the building, such as emergency phones/towers and security cameras.
  - b. Requirements
    - 1) Refer to applicable details on drawings for illustrative requirements.
    - 2) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.
      - a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are NOT to be placed in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.
      - b) These underground conduits shall stub directly into the serving Communications Room/Equipment Room. If not, extend cabling within the building in IMC or RMC to the serving Equipment Room.
    - 3) Approved conduit types:
      - a) When routed below slab-on-grade or outside the footprint of the building:
        - i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.
        - ii) All vertical and horizontal bends and areas subject to vehicular traffic (loads) such as parking lots and roadways shall be RMC or concrete-encased PVC.

#### E. Outlet boxes

1. No outlet boxes shall be located back-to-back in a wall cavity.
  - a. Where possible offset to next stud cavity, with a minimum of 6 inch separation.
2. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
3. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

#### F. Pull Boxes

1. Pull Boxes shall be placed in Conveniently Accessible locations.
2. Coordinate the location and installation of all Pull Boxes to ensure adequate access is provided.
3. Pull Boxes above an accessible ceiling shall:
  - a. Be aligned directly over the ceiling grid to allow access
  - b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles
4. No directional changes shall be allowed in Pull Boxes. Conduit shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
5. Size Pull Boxes according to the following chart:

Metric designator (trade size)	Width mm(in)	Length mm(in)	Depth mm(in)	Width Increase for Additional Conduit mm(in)
27 (1")	102 (4")	406 (16")	76 (3)	51 (2)
35 (1-1/4")	152 (6")	508 (20")	76 (3)	76 (3)
41 (1-1/2")	203 (8")	686 (27")	102 (4)	102 (4)
53 (2")	203 (8")	914 (36")	102 (4)	127 (5)
63 (2-1/2")	254 (10")	1067 (42")	127 (5")	152 (6)
78 (3")	305 (12")	1219 (48")	127 (5")	152 (6)
91 (3 – 1/2")	305 (12")	1372 (54")	152 (6")	152 (6)
103 (4)	381(15)	1524 (60")	203 (8")	203 (8")

### 3.2 LABELING

#### A. Labeling Installation

1. Labels are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

**B. Labeling Requirements**

1. Labels are to be installed on or for:
  - a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section.
  - b. All pathways (e.g., conduit etc.) installed under this work.
    - 1) Label all conduit with "SECURITY". Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.
      - a) For wall stub-up locations, label overhead only.
      - b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.
        - i) Example – "Security to Panel 1 in Equipment Room 127".
      - c) For conduits that stub directly up or into an Equipment Room, label both ends of conduit.
        - i) Example: under slab/ground conduit from Equipment Room 127 to Camera #13 attached to an exterior light pole shall be labeled as follows:
          - (1) Conduit stub-up location in Equipment Room 127 – "Security to Camera #13".
          - (2) In the light pole/junction box, immediately adjacent to serving conduit – "Security to Equipment Room 127".
    - 2) All pullboxes and junction boxes for Security shall be labeled "SECURITY PULLBOX" on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.
      - a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – i.e. "To Security Camera #17 in Room 114".
  - c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.
  - d. Refer to individual Division 28 sections and to the drawings for additional information on labeling requirements.

**3.3 FIRESTOPPING**

**A. General**

1. Provide fire resistant materials of a type and composition necessary to restore fire ratings to all wall, floor, or ceiling penetrations, including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas, or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.
  - a. Assume all floors are fire-rated, unless otherwise noted.
  - b. Also install fire stops at any other locations indicated in the Specifications or Drawings.
3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
  - a. Fire stop Manufacturer
  - b. Installer and company
  - c. Date installed
  - d. UL system number with all relevant ratings indicated
4. Include labels in each Equipment Room in which one or more fire-rated walls is installed. Provide a 2" block letter stencil label on the inside of the room to indicate rating for each barrier.
5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.

**B. Penetration Sealant – Conduits**

1. Provide listed system to seal around openings between wall, floor, or partition around conduits in accordance with system listing and manufacturer's instructions.

**C. Penetration Sealant – Voids, Cavities, and Openings**

1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.

2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
  3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.
- D. Fire-Rated Pathway Device
1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors, or partitions.
  2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
  3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
  4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
  5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

**END OF SECTION**

## **SECTION 281000 - ELECTRONIC SECURITY SYSTEMS**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 CONFIDENTIALITY NOTICE**

- A. Electronic Security System Work is confidential in nature. All drawings and relevant specification sections are considered confidential information and shall remain secure. Track all physical copies of Electronic Security System documents, restrict document access to those working directly on the project; properly dispose of the physical documents when no longer needed. Share and/or restrict access of electronic documents to only those working directly on the project having "a need to know".
  - 1. Proper disposal of physical documents means that they are crosscut shredded, incinerated, or pulped such that there is reasonable assurance the hard copy materials cannot be reconstructed.
  - 2. These confidentiality requirements are a minimum. Follow local, state, and federal laws where more stringent.

#### **1.2 SUMMARY**

- A. Provide a complete and functioning electronically controlled physical security system ("Electronic Security System"), and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether 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, supplies, tools, equipment, transportation, and utilities.
  - 1. All Electronic Security Systems shall have a level of immunity to power interruptions, be time synchronized, and employ a level of redundancy or failure recovery to minimize the loss of data, monitoring, and control.
- B. Specification sections 281000 through 283999, and Drawings numbered with the prefix TY generally describe these systems, but the scope of the Electronic Security System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Fire Alarm System Drawings and Specifications; and Addenda.
  - 1. Provide the following, independent Electronic Security subsystems:
    - a. Expanded Access Control system

#### **1.3 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Work under this section shall follow Division 28 Section "General Electronic Safety and Security Requirements".
- C. Work under this section shall follow Division 28 Section "Common Work Results for Electronic Security Systems" for general pathway, firestopping, access panel, identification, and other requirements.
- D. Requirements of this Section apply to all Sections 281000 through 283999 and vice versa.

#### **1.4 CODES, STANDARDS, AND GUIDELINES**

- A. Follow the most current and up-to-date revisions or printings of the following codes and standards (UON):
  - 1. NFPA 70 – National Electrical Code (NEC)
  - 2. NFPA 101 – Life Safety Code
  - 3. NFPA 730 – Guide for Premises Security
  - 4. NFPA 731 – Installation of Electronic Premises Security Systems
  - 5. IEEE National Electrical Safety Code (NESC)
  - 6. IEEE 802.3af – POE standard
  - 7. IEEE 802.3at – POE Plus standard
  - 8. ANSI TIA-607-C – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
  - 9. ANSI/BICSI 005-2013 – Electronic Safety and Security System Design and Implementation Best Practices

10. ADA Standards for Accessible Design (2010)
11. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
12. BICSI Telecommunications Distribution Methods Manual (TDMM)
13. BICSI Electronic Safety and Security Design Reference Manual (ESSDRM)

## 1.5 ABBREVIATIONS

A.	BICSI	Building Industry Consulting Service International
B.	CCTV	Closed Circuit Television
C.	CPU	Central Processing Unit (computer)
D.	DESI	Detention Electronic Systems Integrator
E.	ESN	Electronic Security Network
F.	ESC	Electronic Security Contractor
G.	ESS	Electronic Safety & Security Designer, a BICSI designation
H.	NJATC	National Joint Apprenticeship and Training Committee
I.	OSP	Outside Plant
J.	PoE	Power-over-Ethernet
K.	RCDD	Registered Communications Distribution Designer, a BICSI designation
L.	RTPM	Registered Telecommunications Project Manager, a BICSI designation
M.	TIA	Telecommunications Industry Association

## 1.6 DEFINITIONS

- A. Electronic Security Contractor (ESC) – The primary contractor of this and all related specification sections (281000 through 283999). The ESC is also responsible for fully coordinating all Electronic Security System requirements with other Divisions and sections, such as power, grounding/bonding, fire alarm, and pathways/other common work.
- B. Equipment Grounding Conductor – as defined in the NEC, the conductive path installed to connect normally non-current-carrying metal parts of equipment together and to the system ground conductor or to the grounding electrode conductor, or both.
- C. Equipment Room – A secured room either exclusively reserved for Security System headend equipment, or shared with other low-voltage systems such as Telecommunications headend equipment, Fire Alarm panels, etc.
- D. Final Acceptance Review – the final site observation by Design Consultant; refer to Submittal paragraph (in Part 1 of this Section) and Project Close-Out Instructions (in Part 3 of this Section) for additional information / requirements.
- E. Security Management System (SMS) - the central component for managing physical security and the bridge between physical and logical security for the project. The system shall provide a variety of integral functions including (but not limited to): regulation of access and egress; provision of identification credentials; monitor, track, and interface alarms and view, record and store digital surveillance video linked to SMS events.
- F. System – short for Electronic Security System, all Work governed by this and related documents.

## 1.7 QUALITY ASSURANCE

### A. Contractor Qualifications

1. ESC shall have a minimum five (5) continuous years in the business of integrating and/or installing Electronic Security equipment including but not limited to the systems identified with the Summary of Work paragraph of this Section.
2. Prior to bidding this project, the ESC shall be a certified installer by the equipment manufacturers whose products shall be incorporated into this project. Post-award certification will not be accepted.
3. ESC shall maintain certification by the manufacturers thru the duration of the warrantee period.
4. When requested, provide a list of projects (no less than 3) of similar size, scope, and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.
5. ESC shall be a direct contractor to the project's Prime Contractor and shall not be sub-contractor under Division 26 or any other Division of Work.
6. Refer to individual sections for additional Contractor qualifications.

### B. Personnel Qualifications

1. Provide and maintain a Quality Control Specialist on staff as a full-time employee at all time. This person shall be familiar with the project and available to attend all scheduled project meetings when required by the Owner/Design Consultant. This person shall conduct weekly inspections and approve all submittals and work performed. This person shall possess one or more of the following:
  - a. Current BICSI RCDD or ESS Designer certification
  - b. Current ASIS Physical Security Professional (PSP) or Certified Protection Professional (CPP)
  - c. An individual with substantial industry experience (10+ years); submit a copy of this person's resume with Pre-Construction submittals and whenever requested.
2. Provide and maintain a qualified Project Manager, who shall be always on-site Work in this (and Related Sections) is being conducted and shall attend all scheduled project meetings. This person shall possess one or more of the following:
  - a. Current BICSI RCDD, ESS or RTPM certification.
  - b. Current ASIS PSP or CPP certification.
  - c. Level III Video Security Systems Technician certification by National Institute for Certification in Engineering Technologies (NICET) and be in good standing.
  - d. Technology-related degree from an ABET accredited institution.
  - e. An individual with significant industry experience as a project manager (5+ years); submit a copy of this person's resume with Pre-Construction submittals and whenever requested.
3. Any additional personnel that will be physically installing any part of the Electronic Security System shall, at a minimum, be in good standing as one of the following:
  - a. NJATC Installer Technician
  - b. BICSI Certified Level 1 Commercial Installer
  - c. NICET Level III Technician (audio, automation, or video)
  - d. Or be assigned to work under the direct supervision and direction of a person holding said certifications.
4. In addition, where required by state and local jurisdictions, any personnel working on-site shall be licensed, for security work or other work as required by this and related sections, and proof of licensure shall be submitted.
5. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
6. Alternate qualifications may be considered. Provide requested alternate considerations prior to Bid in accordance with the Substitution Request instructions in Division 28 Section "General Electronic Safety and Security Requirements".

### C. Warranties

1. Per Division 1, and unless otherwise noted in Division 28 specifications, ESC shall warrant all work to be free of defects in workmanship and materials for a period of 1 year from the date of Substantial Completion.
2. ESC shall provide a point of contact (phone number) for all warranty and service calls, such that the ESC will respond and be on-site within 12 hours of the first call, and the repair completed to the satisfaction of the Owner within 36 hours of arrival on site.
  - a. For issues not properly resolved within this timeframe or those that are unable to be resolved in the field, ESC may elect from the following (subject to approval of the Owner):

- 1) Provide temporary/loaner equipment of comparable function until such time that the component can be fixed or replaced.
  - 2) Reimburse the Owner for additional security staff necessary to cover the down time of that part of the System.
  3. All Warranty Work shall be completed by factory-certified technician(s) of the component(s) being address.
- D. ESC shall visit the job 30 days prior to the end of the 1-year warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.

## 1.8 WORK INCLUDED

- A. Provide labor, materials, and accessories required to install, test and place into operation the Electronic Security System and all sub-systems as called for in the Contract Documents, and in accordance with applicable codes and regulations. Include labor, materials, and accessories not specifically called for in the Contract Documents but required to provide complete operating systems without additional cost to the Owner. The Work includes, but is not necessarily limited to, the general scope of work as presented in the Summary paragraph above.
- B. The Work also includes, but is not necessarily limited to, the following:
1. Conduit, backboxes, pull boxes, firestopping, and other pathways necessary for the completion of all Electronic Security Systems – installed per Division 28 “Common Work Results for Electronic Security”; if another sub-contractor is providing the pathways/common work (as coordinated with the Prime Contractor), the Project Manager and/or Quality Control Specialist of this section shall coordinate and inspect the installation of all pathways/common work with that sub-contractor.
  2. Cabling between the Electronic Security headend equipment and field devices, and between multiple Equipment Rooms.
  3. Full build-out of Equipment Rooms, including all terminations, patch panels, patch cords, cabinets, equipment racks, ladder rack, backboards, etc. Where equipment rooms and pathways are shared with other systems, such as Telecommunications and/or Audio Video, coordinate Division of Labor for shared infrastructure.
  4. A grounding/bonding system, as described in these construction documents, required by equipment manufacturers, and referenced codes and standards.
  5. Appropriate cable supports as required by these construction documents, such that all cabling external to Equipment Rooms is either installed in conduit or supported via J-hooks or cable tray every 48 to 60”.
  6. Testing, labeling, and documentation of all cables and hardware installed under this Division.
- C. Prepare and submit shop drawings, testing reports, as-built drawings, and cabling documentation in a timely manner to conform to all project schedules and timelines.
1. Submittals are a crucial requirement to a successful project. No work may begin until Pre-Construction Submittals have been approved by the Design Consultant.
  2. Incomplete submittals, including submission of unedited bid drawings as shop drawings, will be immediately rejected, and not reviewed.
  3. The first Pre-construction Submittal shall be of such detail and thorough enough to demonstrate to the Design Consultant and Owner that the ESC understands the project requirements and for installers to have sufficient information to complete construction in accordance with the contract documents.
    - a. The project schedule is dependent upon the first pre-construction submittals being thorough enough that only minor edits (if necessary) will be required to be resubmitted.
  4. Accurate Record Drawings and other close-out documentation are integral to the Owner’s use and maintenance of the system and are to be submitted prior to the Final Acceptance Review.

## 1.9 COORDINATION

- A. The locations of outlets, devices, panels, equipment racks and other equipment indicated on the Drawings are approximate and are understood to be subject to such minor revision as may be found necessary or desirable at the time the work is installed to meet field conditions, coordinate with modular requirements of ceilings, simplify the work, establish sight lines for cameras, improve visibility for interactive security devices, or for other legitimate causes.
- B. Exercise particular caution with reference to the location of outlets, devices, control panels, switches, etc. Verify with the Architect the exact location and mounting height of outlets, devices and equipment not dimensionally located on the Drawings.



- C. The Drawings show only the approximate locations of outlets and devices, and, if shown, general run of raceways. Any significant changes in location of outlets, devices, etc., necessary to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Except for unforeseeable extenuating circumstances, modifications shall be made at no additional cost to the Owner.
- D. Camera, door, and device tags in the form of alpha/numeric characters are used where shown to indicate the designation numbers for identification purposes at the equipment panels and/or patch panels. Show the actual camera, door, and device numbers on the as-built Record Drawings, on the associated typed field labels and in the printed and computer readable cabling and device schedules. Submit sample camera, door, and device information tags (proposed labeling scheme).
- E. The drawings do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Under no circumstances shall 40 percent raceway fill be exceeded, regardless of the type of cabling installed.
- F. Provide the correct cable type and quantity as required by the indicated outlets, devices, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NEC and ANSI TIA-569.
- G. All cabling shall be installed complete and unspliced from field device termination to headend termination, unless otherwise noted.
- H. All cabling installed in Damp or Wet Locations (as defined by the NEC) shall be wet rated / listed for installation in a Wet Location.
  - 1. Underground pathways for devices exterior to the building shall stub up directly in the serving Equipment Room; if conduits stub up elsewhere in the building, a junction box is required in an accessible ceiling location and the cabling shall transition from wet-rated to plenum- or riser-rated cabling (per Division 28 Sections "Conductors and Cables for Electronic Security" and "Telecommunications Requirements for Electronic Security").
- I. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that they have the information necessary so that they may properly install the necessary connections and equipment.
  - 1. At a minimum, coordinate the following with the Division 26 Contractor:
    - a. All electrical circuits serving Electronic Security System equipment shall be supplied with an Equipment Grounding Conductor for each circuit.
    - b. All electrical circuits serving Electronic Security System equipment shall have dedicated neutrals (no shared neutrals between branch circuits).
- J. Within two weeks after the Notice to Proceed, schedule a meeting with the Owner's IT and Security staff to coordinate network requirements and programming of the Electronic Security Systems.
  - 1. Refer to Division 28 Section "Network Requirements for Electronic Security" for additional coordination requirements with the Owner's IT staff.

#### 1.10 SUBMITTALS

- A. Refer to requirements in Division 28 Section "General Electronic Safety and Security Requirements". At a minimum, follow these additional requirements:
  - 1. Pre-Bid Submittal (due at the questions deadline during the bid window)
    - a. Substitution Request for any one of the following:
      - 1) Product Substitutions
      - 2) Alternate Personnel Qualifications
      - 3) Contractor Qualifications (for ESCs wishing to be added to the Pre-qualified Contractors list)
  - 2. Pre-Construction Submittal
    - a. Refer to Division 28 Section "General Electronic Safety and Security Requirements" for general Pre-Construction Submittal instructions / requirements.
    - b. Submit the following information for all Electronic Security Work together (Division 281000 through 283900) at the same time, with information grouped in the following categories, then identified by section and in the exact order of the specifications:
      - 1) Cover Page, which includes name of ESC and contact name, phone, and email of the following:
        - a) Quality Control Specialist

- b) Project Manager
- 2) Division of Labor
  - a) Indicate any sub-systems – such as Common Work (conduit, backboxes, etc.), cabling, structured cabling – that will either be provided by a sub-contractor to the ESC or to the Prime Contractor. Indicate the company name that is provided each sub-system.
- 3) Schedule
  - a) Gantt chart format: coordinate with Prime Contractor as needed.
- 4) Equipment List
  - a) Typed list in the following format:
    - i) Product name / type
    - ii) Manufacturer
    - iii) Model name
    - iv) Model number
    - v) Manufacturer Warranty Term (wherever longer than 1 year)
  - b) Separated by specification section and in the exact order as listed in the specification sections.
- 5) Cut Sheets
  - a) Separated by specification section and in the exact order as listed in the specification sections.
- 6) Shop Drawings
  - a) Scaled floor plans, at not less than 1/8" = 1'-0" scale, to identify the following:
    - i) Room names and numbers
    - ii) Door numbers (to match the Architect's Door Schedule)
    - iii) Conduit, firestopping, cable tray, and other common work locations, sizes, and routing, as required by Division 28 Section "Common Work Results for Electronic Security Systems",
    - iv) Cable type, quantities, routing, and approved identification,
    - v) Equipment Room locations and serving areas,
    - vi) Dimensioned device locations and approved identifiers,
    - vii) Where the System controls electronic door hardware, identify type (of electronic door hardware) and voltage for each door.
  - b) Enlarged scaled floor plans and elevations, at not less than 1/4" = 1'-0" scale, of Equipment Rooms, showing 3' of clearance space in front of all panels and wall-mounted racks/cabinets and 3' of clearance space in front of and behind all floor-mounted racks/cabinets.
  - c) Details of the following:
    - i) Termination, or pin-out, details of multiple or multi-conductor cables at the Device and Equipment ends for each type of device.
    - ii) Riser, block, functional, and grounding/bonding diagrams for all systems and sub-systems.
- c. Refer to individual sections in this Division for additional Pre-Construction Submittal requirements.
- 3. Preliminary Project Completion Submittal
  - a. A minimum of 1 week prior to the Final Acceptance Review, submit "Division 28 Electronic Security – Preliminary Project Completion Submittal", to include the following documentation:
    - 1) Resubmit approved Pre-Construction Submittals of the following, updated to reflect all changes during construction:
      - a) Equipment List
      - b) Cut Sheets
      - c) Preliminary Record Drawings – based on drawings kept on site.
        - i) Scans of on-site drawings are acceptable, provided notes and minor changes are legible.
        - ii) These drawings shall include the actual installed device and cable IDs that correspond to submitted test results.
    - 2) Submit the following additional items (as part of each sub-system):
      - a) Operation and Maintenance Manuals
      - b) Test Results for all sub-systems.
        - i) Device and cable IDs shall correspond to submitted Preliminary Record Drawings.
    - 3) And additional items as required in other Division 28 Electronic Security specification sections.
  - b. Refer to the Project Close-Out Instructions in Part 3 of the section for additional information and requirements.
- 4. Final Project Completion Submittal
  - a. After Final Acceptance Review and before Substantial Completion:
    - 1) Address all Punch List items generated from Final Acceptance Review,

- 2) Retest effected items.
- 3) Deliver any spare parts / physical items to Owner.
- b. Submit the following additional items as part of "Division 28 Electronic Security – Final Project Completion Submittal":
  - 1) Cover Page – to include ESC company name and contact information for Warranty issues.
  - 2) (Updated) Equipment List (with length of manufacturer warranty that extends beyond 1 year), Cut Sheets, Operation & Maintenance Manuals, and Test Results
  - 3) (Updated) Record Drawings, in AutoCAD and searchable PDF file formats.
  - 4) Spare Parts / Physical Media Confirmation – included scanned PDF of written confirmation from Owner that all spare parts and physical media were furnished to Owner.
  - 5) Manufacturer Warranty Information and Certificates
- c. Refer to the Project Close-Out Instructions in Part 3 of the section for additional information and requirements.
- d. Refer to individual sections in this Division for additional Project Completion Submittal requirements.

## **PART 2 - PRODUCTS AND MATERIALS**

### **2.1 NOT USED**

- A. Refer to individual Electronic Security System sections for product requirements.

## **PART 3 - EXECUTION**

### **3.1 IDENTIFICATION / LABELING**

- A. General Requirements
  1. The inclusion or installation of any equipment or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited.
  2. Required UL labels shall not be removed, nor shall identification specifically required under the various technical sections of the Specifications be removed.
- B. Refer to individual Electronic Security System sections for additional requirements.

### **3.2 START-UP OF SYSTEMS**

- A. Prior to system start-up, conduct or ensure the following safeguards:
  1. Check all electrical circuits of the various devices for proper wiring polarity, grounding, and activation.
  2. Verify that equipment is effectively bonded and grounded to earth.
  3. Ensure all Equipment Rooms are properly conditioned and free of dust or other contaminants.
  4. Coordinate with Owner's IT department per Division 28 Section "Network Requirements for Electronic Security".

### **3.3 PROJECT CLOSE-OUT INSTRUCTIONS**

- A. Functional Testing
  1. Conduct and finish functional tests of all sub-systems, and integrated testing where applicable. Correct all functional issues prior to requesting the Final Acceptance Review by the Design Consultant.
- B. Preliminary Project Completion Submittal
  1. Submit the following at least 1 week prior to requesting the Final Acceptance Review:
    - a. A copy of Pre-Construction Submittals updated with all changes made during construction.
      - 1) If changes noted on the jobsite work prints are readily legible, a scanned copy is sufficient at this time.
      - 2) Otherwise, obtain reproducible electronic copies of the final Drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done electronically in

BlueBeam\*, AutoCAD or BIM software and saved to PDF format. Each sheet shall contain the ESC's name/logo and be identified as "Preliminary Record Drawing".

- a) \*Final Record Drawings shall be created in AutoCAD or BIM software; annotated PDF drawings will not be accepted.
  - b. Detailed Test Reports of the following sub-systems:
    - 1) Functional Test Reports per individual sections for the following:
      - a) Access Control devices
  - c. Copy of the Operation and Maintenance Manuals for each specified piece of equipment.
- C. Final Acceptance Review
1. Upon completion of all functional testing, request in writing a Final Acceptance Review; this is a final site observation by the Design Consultant. Give the Architect and Design Consultant at least seven (7) days' notice prior to the review. Make the request sufficiently enough in advance for the review to properly be scheduled and completed such that punch list items can be addressed before substantial completion.
  2. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
  3. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
  4. During the Final Acceptance Review, provide the following:
    - a. Services of the Project Manager, as identified in the Quality Assurance part of this Specification Section, and a minimum of two other technicians familiar with the project. The Project Manager shall facilitate the review and demonstration of the Electronic Security System and all sub-systems as requested by the Design Consultants.
      - 1) Provide a minimum of two cell phones or radios to allow two-way communication between the headend or Workstation location and a mobile technician to trigger various security alerts.
    - b. Ladders, lifts, and/or scaffolding as required to reach all cameras or other high-mounted devices.
    - c. Specific test equipment used during the Contractor's preliminary testing activities, and the services of qualified technicians to operate such test equipment.
      - 1) Per individual sections, the Design Consultant may request the Contractor conduct random retesting to confirm the documented test results.
      - 2) Refer to individual sections for exact requirements.
  5. If the Contractor requests a Final Acceptance Review prior to completing the requirements of the Contract Documents, then provide reimbursement to the Design Consultant for time and expenses incurred for the visit.
  6. Upon completion of the review, the Design Consultant will prepare a "punch list" of outstanding items not in compliance with the Contract Documents, to be completed or corrected for final acceptance.
    - a. Omissions on the "punch list" shall not relieve the Contractor from the requirements of the Contract Documents.
- D. Owner Training is not required.
- E. Punch List Completion
1. Complete all punch list items before Substantial Completion.
  2. Retest affected items.
  3. Update Preliminary Project Completion Submittal with all changes.
- F. Project Completion Submittal
1. At the completion of the project, compile the following electronic files, divided into the following sub-folders:
    - a. Equipment List, in PDF and Microsoft Excel format, to include:
      - 1) Specification Section number
      - 2) Quantity
      - 3) Manufacturer
      - 4) Part Number
      - 5) Serial Number
      - 6) Manufacturer's warranty end date, if greater than 12 months after Substantial Completion
    - b. Cutsheets and Operation and Maintenance Manuals
    - c. Record Drawings, in PDF and AutoCAD file formats
    - d. Spare Parts / Physical Media
      - 1) Copy of written documentation indicating that the spare parts were furnished to the owner.
  2. All products and submittals are to be in the exact order as these specifications.

3. Cutsheets and O&M Manuals are to be separate files identified by ## - Product Name – Manufacturer – Model.pdf, where ## is the sequential order of the product in that specification. Example (manufacturer and products may be different for this project):
  - a. 01 – Headend System – Lenel – OnGuard – 7.2
  - b. 02 – Server Software – Lenel – OnGuard – SWS-32ES
  - c. 03 – Workstation – Dell – Precision T3500
  - d. 04 – Controller – Lenel – Intelligent Dual Reader
  - e. 05 – Interface Module – Lenel – Dual Reader Interface Module
  - f. 06 – Power Supply – Altronix – Multi-Output Power Supply
  - g. 07 – Card Reader – HID – Multi-class Reader
  - h. 08 – (continue as needed)
4. Record Drawings
  - a. Refer to Record Drawings paragraph in Division 28 Section “General Electronic Safety and Security Requirements” for additional requirements.
  - b. Record Drawings shall be updated versions of the approved Shop Drawings and shall meet all Shop Drawing requirements.
  - c. Record Drawings for each Electronic Security sub-system shall be provided with final cable routing and pathway routing noted.
    - 1) J-hook / cable routing shall be indicated.
    - 2) Conduit and pullbox routing and locations shall be indicated.
5. After Design Consultant makes comments on the Final Project Completion Submittal, incorporate changes and:
  - a. Save a copy of these files onto the Workstations provided by the ESC.
  - b. Forward updated Final Project Completion Submittal files to Owner. Include file path information for these updated files on the Workstations provided by the ESC.

**END OF SECTION**



## **SECTION 281010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. As part of a complete and functioning Electronic Security System and associated infrastructure, provide conductors and cables of appropriate type. This section includes:
  - 1. Low-voltage Control and Power Cables
- B. Conductor and cable requirements are unique to each manufacturer equipment / device. Unless otherwise noted, exact conductor and cable types are to be coordinated by the ESC to meet the requirements of the Electronic Security manufacturer

#### **1.2 RELATED SECTIONS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Work under this section shall follow Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".
- C. Conductors and cables as specified in this section shall be supported and installed into pathways, backboxes, firestopping, and other general/common work per Division 28 Section "Common Work Results for Electronic Security Systems".
- D. Refer to Division 27 Specifications for all Category 6 and Fiber Optic Cable requirements.
- E. Refer to individual Electronic Security System sections for additional conductor and cabling requirements.

#### **1.3 SUBMITTALS**

- A. Follow the requirements for submittals in Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".
- B. The following additional requirements are due at the following submittal phases:
  - 1. Pre-Construction Submittal
    - a. Cut sheets shall contain the following information for each of the cables specified.
      - 1) Manufacturer's name and logo
      - 2) Cable outside diameter
      - 3) Number of conductors/strands in each cable and binder group
      - 4) Gauge or strand thickness
      - 5) Cable jacket material and rating (i.e. Plenum, Riser, wet-rated, etc.)
      - 6) Maximum pulling tension
      - 7) Jacket/Sheath color
      - 8) Individual conductor or strand insulation colors (if applicable)
      - 9) Minimum bend radius
        - a) During installation and post installation, if different.
    - b. Shop Drawings
      - 1) Cable types required by this Section are to be identified on Shop Drawings for the following Electronic Security sub-systems: (separate 281010 Shop Drawings for this section are not needed)
        - a) Access Control
        - b) Video Surveillance
        - c) Intrusion Detection
      - 2) On the Shop Drawings for those Electronic Security sub-systems, show the proposed routing of all conductors and cables and the means of support:
        - a) Cable Tray
        - b) Conduit (solid line)
        - c) J-hooks every 48"-60" (dashed line), if allowed by Contract Documents

- 3) On the Shop Drawings for those Electronic Security sub-systems, include details showing the proposed termination and labeling (ID) scheme at each device and panel for each conductor/cable.
  2. Preliminary Project Completion Submittal
    - a. Update the approved shop drawings with any changes in cable routing and submit as part of
    - b. Test Results
      - 1) Include conductor/strand test as part of the Functional Test Reports for each Electronic Security sub-system.
    - c. Cable ID spreadsheet, saved in PDF and Microsoft Excel file formats, which shall include the following for each cable installed under this section:
      - 1) Electronic Security Sub-System
      - 2) Device Type
      - 3) Device Identifier
      - 4) Device Room Number (if not part of Device Identifier)
      - 5) Headend Panel Identifier
      - 6) Headend Panel Room Number (if not part of Headend Panel Identifier)
      - 7) Cable Identifier
- | Sub-System     | Device Type/ID | Device Rm     | Headend ID | Headend Rm | Cable ID      |
|----------------|----------------|---------------|------------|------------|---------------|
| Access Control | Card Reader 01 | Vestibule 101 | ACP-01     | IDF 114    | AC-CR01-ACP01 |
3. Final Project Completion Submittal
    - a. Incorporate any changes from punch list items.
    - b. Include updated Cable ID spreadsheet.

#### 1.4 DEFINITIONS

- A. Damp Location – as defined by the NEC, locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. For the purposes of Work under this division, assume all Damp Locations require wet-rated cabling.
- B. Point of Entrance (Building Entrance) – as defined by the NEC, the point within a building where the security cabling routed through a Wet Location emerges from an external wall, a concrete floor slab, or IMC/RMC.
- C. Qualified Electrician – one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved; in regard to this project, a Qualified Electrician is also licensed in the jurisdiction of the project to install electrical equipment (i.e. Journeyman or Master Electrician License).
- D. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 GENERAL REQUIREMENTS

- A. Conductors and cables shall meet the following the requirements:
  1. UL Listed and Approved for the intended application
    - a. Where areas above accessible ceilings are serving as plenum (air) return, and conductors/cabling is not installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Plenum (CMP) rated.
    - b. Where conductors/cabling are installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Riser (CMR) or Plenum rated.
    - c. Where conductors are/cabling are routed through a Wet Location,
  2. Cable type and conductor size/quantity shall be as recommended or required by the device/equipment manufacturer. Where the Contract Documents differ from manufacturer recommendations or requirements, notify the Architect requesting clarification.
  3. Conductor sizes, if shown, are minimum. Where approved by the Design Consultant and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option to utilize stock sizes, provided raceway sizes are increased to correspond with fill ratio requirements defined the NEC.
  4. Conductors and cables shall be shielded.



- a. Submit RFI for any manufacturer equipment that recommends non-shielded cable.
- B. The following Manufacturers are conditionally approved:
- 1. Belden
  - 2. Draka
  - 3. General Cable
  - 4. Tappan
  - 5. West Penn Wire

## 2.2 LOW-VOLTAGE CONTROL AND POWER CABLES

- A. For 10 AWG through 24 AWG, and single conductors through 24-pair applications, as needed per project.
- B. General requirements:
  - 1. Shielded (overall shield)
  - 2. Stranded and insulated conductors
  - 3. PVC jacket
  - 4. Size conductors per manufacturer recommendations and power/voltage drop based on installed cable length.
- C. Manufacturer shall be:
  - 1. Submit product cutsheets concurrently with Shop Drawings, identifying cable type, manufacturer, and part number on the Riser Diagram.
    - a. Call out non-plenum (Riser-rated and Wet-rated) cables (where specifically allowed)

## **PART 3 - EXECUTION**

### 3.1 CABLE INSTALLATION

- A. Pre-Installation
  - 1. Following the Notice to Proceed, the ESC's Quality Control Specialist or Project Manager shall coordinate with the Contractor or Sub-Contractor responsible for Division 28 "Common Work Results for Electronic Security Systems" (i.e. the conduits, backboxes, etc), if Contractors are different. Items of coordination shall include, but are not limited to:
    - a. Conduit routing
    - b. Conduit type for Building Entrance(s) – (see requirements below)
  - 2. Conduit routing and type shall be indicated on at least one of the following Pre-Construction Shop Drawings:
    - a. Division 28 "Common Work Results for Electronic Security"
  - 3. After conduits/pathways are installed, but prior to cable installation, ESC's Quality Control Specialist and Project Manager shall inspect the Common Work (pathways and backboxes), paying special attention to:
    - a. Conduit sizes and quantities matches Construction Documents and Project requirements
    - b. Minimum bend radius
    - c. Quantity of bends in conduit between pullboxes (180 degree change in direction, maximum)
    - d. Building Entrance conduits are of appropriate type
    - e. Any visible indication of improper or incomplete installation that may damage cable as it is installed.
- B. General Requirements
  - 1. Unless otherwise noted, all cables shall be routed through concealed conduit raceway.
    - a. Conduits are not required above accessible (drop) ceilings; when not installed in conduit, cables shall be supported via j-hooks every 48 to 60 inches or less and at every change in direction. For areas where accessible ceiling is not available for pathway back to the Equipment Room, cables may be consolidated and routed in overhead conduit and conduit sleeves.
    - b. Contractor is responsible for determining final cable and conduit routing; conduits may be consolidated in overhead pullboxes in accordance with Division 28 Section "Common Work Results for Electronic Security"; proposed (cable and) conduit routing and sizing shall be indicated on pre-construction shop drawings.
  - 2. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor in backbox at each device location.
  - 3. A Qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
  - 4. All cables shall be plenum-rated, unless noted otherwise.
  - 5. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps,

electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

- a. Except when supported by ladder racking within each Telecommunications room, UON.
  6. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb. tensile strength. Leave at least 12 inches of slack at each end of pull cord.
  7. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
  8. Comply with all referenced standards and guidelines.
  9. Cables shall be masked, covered, or otherwise protected from being painted or contacting any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
  10. Where space allows, all cables shall be provided with slack/service loops near each end of the cable, one in the accessible ceiling space or overhead J-box at the device and one at the Equipment Room. Each slack/service loop shall be:
    11. A minimum of 3 feet (1 meter) in length, unless noted otherwise.
    12. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
  13. Install all cables and conductors in compliance with the requirements of Article 725 of the NEC, paying special attention to the following:
    - a. Cables shall be installed in a neat and workmanlike manner.
    - b. Separation requirements dependent upon installation location and proximity to other circuits.
- C. Outside plant (OSP)/wet-rated cable installation: for cables placed in Wet Locations or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
1. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
  2. Rigid or intermediate metallic conduit shall be used to route outdoor (unlisted) cabling to the serving Equipment Room in accordance with the NEC; or a suitably-sized junction box shall be provided in an accessible location within 50' of where the outdoor cabling/conduit enters the building enters the building to allow the cable to transition from wet-rated to plenum-rated.
    - a. Indicate this location on pre-construction shop drawings and final Record Drawings.

### 3.2 CABLE IDENTIFICATION

- A. Label all cabling with machine-printed labels. Where the drawings and specifications are silent, submit RFI through appropriate channels requesting labeling scheme.
  1. Shop drawings shall include floor plan and/or riser diagram that indicates proposed cable/device identification for each device.
- B. Cables shall be labeled within 6" at each end.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
  1. Brady, IDXPRT
  2. Hellermann Tyton, Spirit 2100
  3. Panduit LS9
  4. Or equivalent

### 3.3 GENERAL CABLE TESTING

- A. Pre-installation testing:
  1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
  2. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.
- B. Post-installation testing (but prior to termination to devices/panels):
  1. Conduct cable continuity testing upon completion of installation on each conductor.
  2. Remove all defective cables from pathway systems. Do not abandon cables in place.

### 3.4 CABLE TERMINATIONS

- A. Cable connections to device and security panel shall be soldered and heat-shrunk from jacket to jacket. Exposed conductors, even within an enclosure or backbox, are not allowed.

### 3.5 ACCEPTANCE

- A. The ESC's Quality Control Specialist shall conduct an inspection after conductors and cabling have been installed to ensure compliance with the Construction Documents and project requirements.
- B. Functional tests of the conductors and cables connected to equipment will be conducted by the ESC as part of Test Reports as specified in individual Electronic Security sub-system Sections.

### END OF SECTION

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## **SECTION 281300 - ACCESS CONTROL**

### **PART 1 - GENERAL REQUIREMENTS**

#### **1.1 SUMMARY**

- A. Provide a complete functioning Access Control System, and each element thereof, as specified, indicated, or reasonably inferred on the Drawings and in this Specification, including every article, device, or accessory (whether 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, supplies, tools, equipment, transportation, and utilities.
- B. This Section consists of the control and monitoring of electro-mechanical barriers that limits physical access to authorized persons to openings (such as a gate or door) of a secured area (such as a property, facility, room, or cabinet). The system shall also monitor openings and initiate alarm if opening is forced open or left open for a set time.
- C. The Access Control System shall consist of, but is not limited to, the following components:
  - 1. Integration to System Software and additional licensing for new card reader.**
  - 2. Existing Head-end Equipment needs to be expanded to accommodate additional reader. Refer to plans.**
  - 3. Client Workstation PCs and Software and Desktop UPS units are not required.**
  - 4. Devices:**
    - a. Credential card reader**

#### **1.2 RELATED SECTIONS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Work under this section shall follow Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".
- C. Pathways and other Common Work required by this section shall be provided per Division 28 section "Common Work Results for Electronic Security".
- D. Cabling required by this section shall be provided per Division 28 section "Conductors and Cables for Electronic Security".

#### **1.3 CODES, STANDARDS, AND GUIDELINES**

- A. Refer Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems" for a complete list of Codes, Standards, and Guidelines that Work under this section shall follow.

#### **1.4 ABBREVIATIONS AND DEFINITIONS**

- A. ACS: Access Control System
- B. API: Application Programming Interface
- C. Central Station: A PC/Server with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.
- D. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.
- E. CPU: Central processing unit.

- F. Credential: Data assigned to an entity and used to identify that entity.
- G. EMI: Electromagnetic Interference.
- H. ESS: Electronic Security System.
- I. Fail-Safe (Door): if power fails, the door is to unlock.
- J. Fail-Secure (Door): if power fails, the door remains secure (locked).
- K. Server: A PC in a network that stores the programs and data files shared by users.
- L. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- M. I/O: Input/Output.
- N. LAN: Local area network.
- O. LDAP: Lightweight Directory Access Protocol.
- P. LED: Light-emitting diode.
- Q. Location: A Location on the network having a PC-to-Controller communications link. Where this term is presented with an initial capital letter, this definition applies.
- R. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.
- S. PIN: Personal Identification Number.
- T. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.
- U. RF: Radio frequency.
- V. RS-232: A TIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.
- W. RS-485: A TIA standard for multipoint communications.
- X. UPS: Uninterrupted power supply.
- Y. VMS: Video Management System.
- Z. WAN: Wide area network.
- AA. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- BB. Workstation: A PC with software that is configured for specific limited access control system functions.
- CC. WYSIWYG: (What You See Is What You Get.) Text and graphics appear on the screen the same as they will print.

## 1.5 QUALITY ASSURANCE

- A. Contractor Qualifications

1. The Access Control System shall be provided by the Electronic Security Contractor (ESC), as defined in Division 28 Section "Electronic Security Systems".
  - a. The ESC shall be a certified installed of the ACS vendor prior to bid; post-bid certification will not be accepted.
  - b. The ESC shall be pre-qualified; refer to Quality Assurance paragraph in Division 28 Section "Electronic Security Systems" for a list of pre-qualified contractors, and instructions for potential bidders wishing to become pre-qualified.

B. Personnel Qualifications

1. Refer to Division 28 Section "Electronic Security Systems" for personnel qualifications.

1.6 WARRANTIES

- A. Refer to Division 28 Section "Electronic Security Systems" for warranty requirements.

1.7 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Sections "General Electronic Safety & Security Requirements" and "Electronic Security Systems".
- B. Pre-Bid Submittal - the following submittals are due before the questions deadline before Bid:
1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- C. Pre-Construction Submittal
1. Refer to Division 28 Section "Electronic Security Systems" submittal requirements, with additional requirements as noted:
    - a. Product Cutsheets and Shop Drawings shall be submitted concurrently as part of the complete Electronic Security Systems pre-construction submittal. If the first submittal only includes Product Cutsheets, submittal will be returned "Not Reviewed".
    - b. Shop Drawings:
      - 1) Submit plans, elevations, and details that include the following:
        - a) Indicate all system device locations on architectural floor plans, identified by number/ID. No other system(s) shall be included on these plans.
        - b) Enlarged Equipment Room wall elevation(s), indicating all wall-mounted pathways/cable management, wall-mounted enclosures, and all internal components of wall-mounted enclosures.
          - i) All components on these elevations shall be identified by part name, manufacturer, and model number.
        - c) Include full schematic wiring information on these drawings for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at device.
        - d) Include a complete ACS one-line, block diagram.
          - i) Each far-end device shall be identified by number/ID and room number.
        - e) Include a statement of the system sequence of operation.

D. Preliminary Project Completion Submittal

1. Refer to Division 28 Section "Electronic Security Systems" submittal requirements, with additional requirements as noted:
  - a. Test Results for the Access Control System. Refer to Project Close-Out Instruction in Part 3 of this section and Division 28 Section "Electronic Security Systems" for additional information and requirements.

E. Final Project Completion Submittal

1. Refer to Division 28 Section "Electronic Security Systems" submittal requirements, with additional requirements as noted:
  - a. Include scan of written documentation that Spare Parts / Physical Media were delivered to Owner at time of Owner Training.

2. Refer to Project Close-Out Instruction in Part 3 of this section and Division 28 Section "Electronic Security Systems" for additional information and requirements.

## PART 2 - **PRODUCTS AND MATERIALS**

### 2.1 GENERAL

- A. System Description
  1. Expansion of Owner's Existing Access Control System
    - a. System shall consist of an existing access control panel expanded to accommodate additional reader. Refer to plans.

### 2.2 ACCESS CONTROL SYSTEM SOFTWARE

- A. Owner's Existing Access Control System shall remain as is.**

### 2.3 HEAD-END EQUIPMENT

- A. Provide Mercury MR52 board to expand existing access control system.**

### 2.4 DEVICES:

- A. Card Readers shall be capable of the HID Proximity protocol and manufactured by HID.
- B. Request-to-Exit Buttons - for door release applications
  1. Desk Mounted
    - a. Description: momentary SPDT push switch to release (unlock) an access-controlled door.
    - b. Manufacturer:
      - 1) Momentary (MO) Push Button: Security Door Controls D15-2.

## PART 3 - **EXECUTION**

### 3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 CABLING

- A. Provide cabling for all access controlled doors and gates identified on the drawings and these specifications. Cable type and size shall meet all ACS vendor requirements for each type of device / connection. Coordinate the required cable specifications with Division 28 "Conductors and Cables for Electronic Security" contractor (if different from the ESC) prior to Bid.
  1. Utilize shielded cables/conductors unless ACS vendor specifically forbids the use of shielded cables/conductors.
  2. Use of a multi-conductor composite cable to access controlled doors is preferred, but not required, unless otherwise noted.
  3. Coordinate cable size and pathway requirements with Division 28 "Common Work Results for Electronic Security" contractor.
- B. Comply with NECA 1, "Good Workmanship in Electrical Construction."



- C. Cables and wiring shall be installed according to requirements in Division 28 Section "Conductors and Cables for Electronic Security."
- D. Boxes and enclosures containing ACS components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- E. Ensure machine-printed, thermo-plastic labels are installed within 12" of each end of all cables.
- F. Maintain insulation on all conductors to the final termination point within the enclosure; exposed copper conductors of any length are not allowed.
- G. Provide a minimum of 6 inches of slack (service loop) at both ends of all cabling (at the device and within the ACS enclosure).

### 3.3 CABLE APPLICATION

- A. Coordinate these requirements with Division 28 "Conductors and Cables for Electronic Security" contractor.
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling (if required): Install at a maximum distance of 50 ft.
- D. TIA 485-A Cabling (if required): Install at a maximum distance of 4000 ft.
- E. Card Readers and Keypads:
  - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
  - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft.
  - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
  - 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not allow voltage drop from power supply to lock to drop below manufacture's stated minimum operating voltage.
- G. Install minimum No. 14 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft.

### 3.4 GROUNDING AND BONDING

- A. Properly ground/bond all ACS equipment in accordance with manufacturer's instructions and per the drawings and Division 28 section "Equipment Room Fittings for Electronic Security".
- B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Bond shields and drain conductors to ground at only one point in each circuit.
- D. Each entrance protector shall have its own ground/bond conductor to the TGB; do not bond to ACS enclosure.
- E. Each ACS enclosure shall have its own ground/bond conductor to the TGB; do not daisy-chain enclosures together.
- F. Minimum bonding/conductor size, in accordance with "Equipment Room Fittings for Electronic Security", is #6 AWG.

### 3.5 IDENTIFICATION & LABELING

- A. Develop a system identification, testing, and management plan. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
  - 1. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  - 2. Enclosures shall be labeled with 2" by 4" engraved plastic label with 3/4" tall white characters. Attach label to enclosure door/cover with screws that do not extend more than 1/8" into the interior of the door/cover.
- B. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the device as shown.
- C. At completion, Record Drawings and cable and equipment spreadsheets shall reflect as-built conditions.

### 3.6 HEAD-END EQUIPMENT

- A. Furnish, install, and configure (program) all required controllers, interfaces, and accessories in the rooms identified on the plans.
- B. All head-end equipment shall be within existing wall-mounted enclosures.
- C. Card Readers
  - 1. ADA actuator doors
    - a. Doors with ADA operators and managed by ACS shall be cabled, configured, and programmed to require valid credential before ADA push-button can actuate respective door opener.

### 3.7 FIELD QUALITY CONTROL

- A. Refer to Part 3 of Division 28 section "Electronic Security Systems" for general installation and project close-out instructions.
- B. Perform the following functional tests and inspections - and correct any issues - before requesting Final Acceptance Review by Design Consultant:
  - 1. Follow Test Methods as required by ACS vendor.
  - 2. Also follow Test Methods as listed in NFPA 731 Standard for the Installation of Electronic Premises Security Systems (2017), Table 10.4.3(a) and Table 10.4.3(b)
  - 3. Test Reports:
    - a. Utilize Sample Record of Completion Report from NFPA 731 Standard for the Installation of Electronic Premises Security Systems (2017), Figure A.4.12.2.1(3)(a) as cover page of Access Control Test Reports.
    - b. Utilize Sample Access Control Report from NFPA 731 Standard for the Installation of Electronic Premises Security Systems (2017), Figure A.4.12.2.1(3)(c) to document testing of all ACS components.
    - c. Scan to PDF and combine these reports, arranged logically by serving Equipment Room and Device type/ID. Include this PDF as part of Preliminary Project Completion Submittal.
- C. After Final Acceptance Review by Design Consultant, address/correct any issues, and re-test effected devices and components of the ACS.
  - 1. Update Test Reports and include complete Test Reports as part of Final Project Completion Submittal.

### 3.8 STARTUP SERVICE

- A. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
- B. Enroll and prepare credentials for Owner's operators, management, and security personnel.

**3.9 OWNER TRAINING IS NOT REQUIRED.**

**END OF SECTION**



## **SECTION 284600**

### **FIRE DETECTION AND ALARM**

#### **PART 1 - GENERAL**

##### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following sections contain requirements that relate to this Section:

##### **1.2 DESCRIPTION OF WORK**

- A. This Section requires the Contractor to furnish all materials required to install the fire alarm system. The Contractor shall be responsible for installing, testing, and start-up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities.
- B. Division 28 of the Specifications and Drawings numbered with prefixes FA generally describe these systems, but the scope of the Fire Alarm work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically and are intended to convey the scope of work, indicating the general location and arrangement of the major equipment, devices, appliances, etc. without showing all the exact details as to elevations, circuits, routing, and other installation requirements. Use the Drawings as a guide when laying out the system and verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. The scope of work in this section includes:
  - 1. Manual fire alarm pull stations
  - 2. System smoke detectors
  - 3. Heat detectors
  - 4. Carbon monoxide detectors
  - 5. Notification appliances
  - 6. Magnetic door holders
  - 7. Elevator recall
  - 8. Air handling unit shutdown
  - 9. Battery stand-by power
  - 10. Multi-channel one-way voice notification system

##### **1.3 QUALITY ASSURANCE**

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality,

size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

- D. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 2 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

#### 1.4 APPLICABLE CODES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities. Upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.
  - 1. NFPA 70, "National Electrical Code", 2017 Edition.
  - 2. NFPA 72, "National Fire Alarm and Signaling Code", 2016 Edition.
  - 3. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
  - 4. International Building Code (IBC) 2018 Edition with local amendments.
  - 5. International Fire Code (IFC) 2018 Edition with local amendments.
- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

#### 1.5 DEFINITIONS

- A. General:
  - 1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
  - 2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
  - 3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
  - 4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
  - 5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
  - 6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
  - 7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the AHJ over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

- 8. FACP: Fire Alarm Control Panel.
- 9. NICET: National Institute for Certification in Engineering Technologies.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

#### 1.6 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.
- C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Fire Alarm systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.
- E. Where coordination and interfacing with other systems or equipment is required, it shall be the responsibility of the fire alarm system installer (contractor) to either provide the relays, contacts, power supplies and other necessary hardware or see to it that such hardware is provided with the other systems or equipment.
- F. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:
  - 1. Duct smoke detectors shall be furnished, wired and connected by the fire alarm system installer. The HVAC installer shall furnish necessary duct opening to install the duct smoke detector's housing.
  - 2. Air handling fan control circuits and contacts to be furnished by the HVAC control equipment.
  - 3. Conduit shall be installed per NFPA 70 and 72.
- G. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

#### 1.7 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

#### 1.8 SUBMITTALS

- A. Refer to Division 1 and General Conditions for submittal requirements, in addition to requirements specified herein. Submittals not complying fully with the submittal requirements will be rejected.

- B. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval.
- C. Shop drawings shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations. Drawings that are not legible, or that do not contain sufficient detail to verify compliance with applicable codes and standards, will be rejected without further review.
- D. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall it contain the HEI's engineers' seal and signature. They shall not be copies of HEI's work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.
- E. Submit Shop Drawings as early as required to support the project schedule. Allow for two weeks Engineer review time plus mailing time plus a duplication of this time for resubmittal if required. Submit Shop Drawings as soon as possible before construction starts.
- F. Before submitting Shop Drawings and material lists, the Contractor shall verify that the equipment submitted is mutually compatible and suitable for the intended use. Contractor shall verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- G. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- H. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless the Contractor has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.
- I. Product Data: Provide a bill of materials and product cutsheets showing material specifications, electrical characteristics and connection requirements. Highlight or indicate specific product options and accessories as applicable to the project.
- J. Shop Drawings:
  - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
  - 2. Shop drawings shall be prepared by a NICET Level II or higher certified technician. Submit copies of the certification for the designer with submittal.
  - 3. The fire alarm system equipment vendor shall provide shop drawings showing fire alarm floor plans and a full building riser diagram. Fire alarm floor plans and riser diagram shall show fire alarm control panel, annunciator, all fire alarm initiating devices and notification appliances. Show typical wiring diagrams of control panel/s, annunciator and each device and wiring connections required. Show all interfaces to other systems, such as temperature control systems, and security systems.
  - 4. The fire alarm floor plans and riser diagram shall show wiring to all fire alarm devices/appliances, indicating wire sizes and quantities as well as conduit/raceway sizes



and locations of end-of-line (EOL) resistors. The fire alarm floor plans and riser diagram shall clearly show the routing of all fire alarm system wiring, including all horizontal routing and vertical routing (in chases).

5. Routing of all fire alarm wiring shall comply with the "Survivability" requirements of NFPA 72.
  6. Provide a Sequence of Operations Matrix that explains how the submitted fire alarm system functions.
  7. Include voltage drop calculations for notification-appliance circuits.
  8. Include battery-size calculations.
  9. Shop drawing scale shall match the Engineer's drawings where possible. Scale shall not be less than  $3/32" = 1'-0"$ .
  10. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.
- K. Indicate within the submittal all applicable UL listings and all applicable approvals or certifications.
- L. Qualification Data: Submit copies of the certification for the Installer.
- M. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

#### 1.9 ELECTRONIC DRAWING FILES

- A. In preparation of shop or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall complete and send the form attached at the end of this section along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

#### 1.10 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for Substitutions.
- B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and other information necessary for an evaluation. A statement setting forth changes in other materials, equipment or other Work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Engineer's decision of approval or disapproval to bid of a proposed substitution shall be final.
- D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
- E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

#### 1.11 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1 and General Conditions for Operational and Maintenance Manuals.
- B. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- C. The O&M Manuals shall be provided in labeled 3-ring binder with cover, binding label, tabbed fly sheets and plastic insert folders for Record Drawings. Include the following sections with the appropriate information for each section:

1. Typewritten Index.
2. Qualifications. Provide designer and installer qualification.
3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
5. Product Data: Provide product cutsheets for all equipment utilized and installed.
6. Riser diagram.
7. Device addresses.
8. Record copy of site-specific software.
9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
  - a. Equipment tested.
  - b. Frequency of testing of installed components.
  - c. Frequency of inspection of installed components.
  - d. Requirements and recommendations related to results of maintenance.
  - e. Manufacturer's user training manuals.
10. Manufacturer's required maintenance related to system warranty requirements.
11. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.
12. Guarantee. Copy of all guarantees and warranties issued.
13. Contact list with minimum three service representative phone numbers.

#### 1.12 RECORD DRAWINGS

- A. A set of prints shall be kept on the jobsite during construction for the purpose of noting changes to location of all fire alarm equipment, devices, appliances and circuits as finally installed. During the course of construction, the Contractor shall indicate on these drawings, changes made from the Contract Drawings. Particular attention shall be made to those items which need to be located for servicing.
- B. The record drawings shall show actual locations of initiating devices, notification appliances, and end-of-line devices. Show the approximate location, size and type of all wiring and routing of wiring. Drawings should also include one-line riser diagrams showing all devices.
- C. The Contractor shall sign-off on the Record Drawings as being an accurate representation of the completed installation.
- D. Refer to Division 1 and General Conditions for Record Drawings
- E. At the completion of the project, the Contractor shall obtain at their expense, reproducible copies of the drawings and incorporate changes noted on the jobsite work prints onto these sheets. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", with date. The drawings and associated system calculations shall be delivered to the Architect.

#### 1.13 SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Provide 10% of the total or a minimum of one (1) manual pull station.
  2. Provide 10% of the total or a minimum of two (2) of each type of automatic smoke detector.
  3. Provide 5% of the total or a minimum of one (1) of each type of automatic heat detector.
  4. Provide 5% of the total or a minimum of two (2) of each strobe type and candela rating.
  5. Provide 5% of the total or a minimum of two (2) of each speaker type. Combination speaker/strobe units matching the units installed are acceptable.
  6. Keys and Tools: One extra set for access to locked or tamper proofed components.

#### 1.14 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products indicated in this section with minimum three years documented experience.
- B. Installer: Company specializing in installing the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed Contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire alarm submittal proof of factory training for each installer.
- C. Final checkout and verification: Shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET) registered as level 2 or higher in the fire protection technology certification program. Provide certification information with fire alarm submittal.
- D. The equipment manufacturer's service department shall be fully stocked in standard parts and components and engaged in the maintenance of fire alarm systems. On-the-premises service shall be available within 4 hours of notification, 7 days a week, 24 hours a day.

#### 1.15 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties.
- B. Furnish service and maintenance of fire alarm system including wiring and raceways for one year from date of substantial completion.
- C. All components, system software, parts and assemblies shall be guaranteed against defects in materials and workmanship for the one-year period stated above, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty.
- D. Labor (including travel expenses) to trouble-shoot, repair, reprogram, or replace components shall be furnished by this contractor at no charge during the warranty period.
- E. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software.

#### 1.16 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:
  - 1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting a bid to determine the nature and extent of work involved.
  - 2. Work in the existing building shall be scheduled with the Owner.
  - 3. Certain demolition work must be performed prior to the remodeling. The Fire Alarm Contractor shall perform the demolition which involves fire alarm system equipment and materials.
  - 4. Fire Alarm Contractor shall remove articles which are not required for the new work. Unless otherwise indicated, each item removed by the Contractor during this demolition shall be removed from the premises and disposed of in accordance with applicable federal, state and local regulations.
  - 5. Fire Alarm Contractor shall relocate and reconnect fire alarm equipment that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. General Contractor shall install finish material.
  - 6. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
  - 7. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
  - 8. Locate, identify, and protect Fire alarm services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed including the performance of auxiliary equipment and functions.

- C. Interruption of Existing Fire alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire watch service according to local Fire Department requirements:
  - 1. Notify Owner no fewer than seven days in advance of proposed interruption of fire alarm service.
  - 2. Do not proceed with interruption of fire alarm service without Owner's written permission.
- D. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

#### 1.17 SEQUENCING AND SCHEDULING

- A. Existing Fire alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire alarm system, remove all unused fire alarm equipment, wiring and installation materials not necessary for system functionality or spare parts.

## **PART 2 - PRODUCTS AND MATERIALS**

### 2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-listed addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- B. All components provided shall be listed for use with the selected system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Source Limitations for Fire alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested, and will operate, as a system.

### 2.2 MANUFACTURER

- A. Subject to compliance with requirements, provide products manufactured by the following manufacturers as indicated on the Drawings:
  - 1. Edwards

### 2.3 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire alarm signal initiation shall be by one or more of the following devices and systems:
  - 1. Manual pull stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.
  - 4. Carbon monoxide detectors.
  - 5. Fire extinguishing system operation.
- B. Fire alarm signal shall initiate the following actions:
  - 1. Identify alarm and specific initiating device at fire alarm control unit and remote annunciators (if provided).
    - a. A pulsing alarm tone shall occur within the control panel until acknowledged.
    - b. The alarm LED shall flash on the control panel and remote annunciator panel until the alarm has been acknowledged at the control panel/remote annunciator panel. Once acknowledged, this same LED shall latch on and the custom label for the address in alarm shall be displayed on the alphanumeric LCD readout. A subsequent alarm received from another address after acknowledged shall flash the alarm LED on the control panel showing the new alarm information.
  - 2. Transmit an alarm signal to the alarm supervising station.

3. The audible and visible alarm signal shall operate until it is manually silenced or acknowledged.
  4. Record events in the system memory.
  5. Release fire and smoke doors held open by magnetic door holders.
  6. Activate voice/alarm communication system.
  7. All fan-powered air-handling equipment shall shutdown and remain down until the fire alarm control panel is reset.
  8. Shutdown audio system.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Duct-smoke detectors
  2. Independent fire detection and suppression systems.
  3. User disabling of zones or individual devices.
  4. Loss of communication with any panel on the network.
- D. System Supervisory Signal Actions:
1. Identify specific device causing supervisory signal fire alarm control unit and remote annunciators (if provided).
    - a. Visible and audible supervisory alarm indicated by address at fire alarm control panel.
    - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible supervisory alarm; visible alarm is displayed until device is returned to its normal position/supervisory condition is cleared.
  2. Record events in the system memory.
  3. After a time delay of 90 seconds transmit a supervisory signal to the alarm supervising station.
  4. Duct-mounted smoke detectors shall shutdown their respective unit upon detection of smoke and remain down until manually reset.
  5. Individual fan-powered air distribution equipment less than 2,000 cfm that is not provided with duct detection shall shutdown when the respective air handling unit is shutdown.
- E. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
  2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
  4. Loss of primary power at fire alarm control unit.
  5. Ground or a single break in internal circuits of fire alarm control unit.
  6. Abnormal ac voltage at fire alarm control unit.
  7. Break in standby battery circuitry.
  8. Failure of battery charging.
  9. Abnormal position of any switch at fire alarm control unit or annunciator.
  10. Voice signal amplifier failure.
- F. System Trouble Signal Actions:
1. Identify specific device causing trouble signal fire alarm control unit and remote annunciators (if provided).
    - a. Visible and audible trouble alarm indicated by address at fire alarm control panel.
    - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible trouble alarm; visible alarm is displayed until device is returned to its normal position/trouble condition is cleared.
  2. Record events in the system memory.

3. After a time delay of 90 seconds, transmit a trouble signal to the alarm supervising station.

## 2.4 FIRE ALARM SYSTEM CONTROL UNIT

- A. Fire alarm control unit is existing to remain.
- B. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm communicator transmitters shall be powered by 24-V dc source.
  1. The location of the dedicated branch circuit disconnecting means shall be permanently identified at the control unit.
  2. The circuit disconnecting means shall have a red marking and be provided with a breaker lock or other approved method to avoid accidental operation.
  3. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
- C. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
  1. Batteries: Sealed lead acid.
  2. The secondary power system shall operate system in standby mode for 24 hours followed by alarm mode for 15 minutes.
- D. Elevator Recall and Shutdown: Provide output signals to the elevator controller(s) using addressable relays to initiate elevator recall and shutdown functions per ASME A17.1. Provide equipment, output signals and logic as required by code and by the elevator system supplier and installer.
  1. Elevator recall shall be initiated by any one of the following alarm-initiating devices:
    - a. Elevator lobby detector(s).
    - b. Smoke detector in elevator machine room.
  2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
  3. Elevator shutdown shall be initiated by any one of the following alarm-initiating devices:
    - a. Heat detector in elevator machine room.

## 2.5 EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEMS (EVACS):

- A. The system shall incorporate one-way emergency voice communication via specified speakers. A central audible module shall provide for the necessary alarm message/tone generation, main and remote microphone connections and mixers/pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure (main microphone trouble, tone trouble, etc.)
  1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
    - a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    - b. Programmable tone and message sequence selection.
    - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire alarm control unit.
  2. Hand held push to talk, noise canceling microphone in recessed protective panel mounted enclosure; 5 feet coiled cable; and LED to indicate the microphone push to talk has been pressed.
  3. Audible power amplifiers shall be self filtered; contain 24 volt power supply, transformer and amplifier monitor circuits; Amplifier shall operate all system speakers plus twenty-five (25) percent spare capacity.

4. Digitized voice messages are required to notify building occupants during alarm conditions. Message player shall not rely on tape or mechanical means of transmitting the voice message. A standard evacuation message shall be provided; however, the system shall be capable of transmitting a custom message of up to five (5) minutes long.
5. Alarm sequence shall consist of a temporal (3) alarm tone for a maximum of 15 seconds followed by an automatic pre-selected message. At the end of the message the tone shall resume. This sequence shall continue until the fire alarm control panel has been silenced. Manual voice paging shall be available via panel switches to page individual floors or groups of floors. Each floor shall be an individual audible zone and have a corresponding audible switch.

## 2.6 REMOTE ANNUNCIATOR

- A. Description: Alphanumeric display and LED indicating lights shall match those of fire alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
  1. Mounting: semi-recessed.
  2. Provide remote microphone and emergency/voice alarm system controls.

## 2.7 INITIATING DEVICES

- A. Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
  1. Double action mechanism requiring two actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control unit.
  2. Station Reset: Key or wrench operated switch.
  3. Indoor Protective Shield: Factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
- B. System Smoke Detectors: Photoelectric type complying with UL 268 operating at 24-V dc, nominal with integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.
  1. Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
  2. Device shall have an integral visual-indicating light, LED type, indicating detector has operated and power-on status.
  3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  4. Photoelectric detectors shall have sensitivity between 0.5 and 3.5 percent/foot smoke obscuration.
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer's standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.
  1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
  2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.
  3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
  4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.
  5. Provide remote alarm LEDs and remote test stations as shown on the plans.

6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
- D. Carbon Monoxide Detectors: Detector complying with UL 2075 and listed for connection to fire alarm system. Detector shall include alarm contacts and trouble contacts. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults. Locate, mount, and wire according to manufacturer's written instructions. Testable by introducing test carbon monoxide into the sensing cell. Test button simulates an alarm condition.
- E. Heat Detectors – Comply with UL 521. Detector shall have twist lock base interchangeable with smoke detectors bases and be equipped with an integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.
  1. Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

## 2.8 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
  1. Combination Devices: Factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections. Minimum audible level and strobe intensity shall meet all requirements for separate appliances.
  2. Provide strobe synchronization as required per NFPA 72.
  3. Wall mounted notification appliances shall be manufacturer standard white finish.
  4. Ceiling mounted notification appliances shall be manufacturer standard white finish.
- B. Alarm Speakers: Comply with UL 1480. High quality tone and voice reproduction; capacitor connected for connection to supervised notification appliance circuit; semi-flush mounting; four inch cone; high impact, flame retardant PC/ABS thermoplastic; 25 or 70 VRMS; multi-tapped output power rated ¼ to 2 watts and produce 79 to 88 dB at 10 feet.
- C. Visible Alarm Notification Appliances (Strobes): Xenon strobe lights complying with UL 1971, unfiltered or clear filtered white light, with candela ratings as indicated on drawings. Strobes shall meet all requirements of the Americans with Disabilities Act.

## 2.9 AUXILIARY DEVICES

- A. Magnetic Door Holders: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
  2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  3. Rating: 24-V ac or dc.
- B. Monitor Module: Addressable microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts. Include address setting means on the module.
- C. Control/Relay Module: Provide intelligent control relay modules. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

## 2.10 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for smoke detectors, notification appliances, or other device requiring protection as indicated on the plans.
  1. Factory fabricated and furnished by device manufacturer.
  2. Finish: Factory finished to match the color of the protected appliance or device.

## 2.11 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Building wire in accordance with NFPA 70 and 72.



- B. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.
- C. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.
- D. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.
- E. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.
- F. Conduit and Boxes: Comply with requirements of NFPA 70 and 72.
- G. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket and red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated.
- H. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits: Provide circuitry, which meets the performance requirements during abnormal conditions, based upon the class of the circuitry selected.
  - 1. Initiating Device Circuits: Class B
    - a. Pathway Survivability: Level 0
  - 2. Notification Appliance Circuits: Class B
    - b. Pathway Survivability: Level 0
  - 3. Signaling Line Circuits: Class B
    - c. Pathway Survivability: Level 0
  - 4. Any circuits interconnecting fire alarm control panels between separate buildings shall be provided with surge protection.

## 2.12 ACCESS TO EQUIPMENT

- A. All detectors, modules, equipment, etc. shall be located so as to provide easy access for operation, service inspection and maintenance.
- B. Access Doors:
  - 1. Provide access doors for all concealed equipment, except where above lay-in ceilings.
  - 2. Access doors shall be adequately sized for the devices served with a minimum size of 18" x 18", furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
  - 3. Access doors must be of the proper materials for type of construction where installed.
  - 4. The exact location of all access doors shall be verified with the Architect prior to installation.
  - 5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
  - 6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
    - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
    - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
  - 7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
    - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

8. Locking Devices: Flush, screwdriver-operated cam locks.
9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.
10. 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. Arrow United Industries.
  - b. Bar-Co., Inc.
  - c. J.L Industries.
  - d. Karp Associates, Inc.
  - e. Milcor Div. Inryco, Inc.
  - f. Nystrom Building Products
  - g. Wade
  - h. Zurn

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. The Contractor shall install, program and test all new equipment identified in this contract and revise existing equipment as noted in accordance with the applicable codes, standards, and manufacturer's instructions.
- B. The installation supervisor shall be on the job site during the entire installation. The installation supervisor shall maintain marked up copies of the drawings at the job site showing as-built conditions. These drawings shall be updated daily and available for Owner review.
- C. The Contractor shall provide all required conduit and all associated hardware, and shall install (pull), connect, and test all cable for a complete fire alarm system. All wiring shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

#### **3.2 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.3 EQUIPMENT INSTALLATION**

- A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
  1. Devices placed in service before all other trades have completed cleanup shall be replaced.
  2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.
  1. Connect new equipment to existing control panel.
  2. Expand, modify, and supplement existing control/monitoring equipment as necessary to extend existing functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

- C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
  - D. Manual Fire alarm Boxes: Provide manual fire alarm boxes as shown on drawings. Mount manual fire alarm box on a background of a contrasting color. The operable part of manual fire alarm box shall be at 48 inches above floor level unless noted otherwise.
  - E. Smoke and Heat Detectors: Provide detectors as shown on drawings.
    - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.
    - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat detector spacing.
    - 3. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
    - 4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
    - 5. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
    - 6. Install ceiling mounted detectors in areas with exposed structure tight to underside of floor/roof deck unless noted otherwise on drawings.
  - F. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.
    - 1. Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.
    - 2. Provide duct detection and shutdown for fan powered air distribution equipment exceeding 2,000 cfm.
    - 3. Provide equipment and connections to shutdown fan powered air distribution equipment with a capacity less than 2,000 cfm that are part of an air distribution system with a capacity greater than 2,000 cfm.
  - G. Carbon Monoxide Detections: Provide detectors as shown on drawings. The installation shall comply with manufacturer's recommendations and NFPA 720, "Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment," as referenced by NFPA 72.
  - H. Elevator Shafts: Do not install smoke detectors in unsprinklered elevator shafts.
  - I. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector that is not readily visible from normal viewing position.
  - J. Install ceiling mounted visible and audible/visible notification appliances in areas with exposed structure to bottom of floor/roof structure or at 30 ft AFF, whichever is lower.
  - K. Install ceiling mounted visible and audible/visible notification appliances in areas with finished ceilings flush with bottom of ceiling or at 30 ft AFF, whichever is lower.
  - L. Install wall mounted visible and audible/visible notification appliances with visible element (strobe) between 80 inches and 96 inches above finished floor unless noted otherwise on drawings.
  - M. Install wall mounted audible devices with the top of the device at least 90 inches above finished floor or 6 inches below the ceiling, whichever is lower, unless noted otherwise on Drawings. If combination devices are installed, they shall be installed per the visible signal device requirements.
  - N. All notification appliance speakers shall be tapped at ½ watt unless noted otherwise on drawings. In rooms less than 100 sq ft, speakers are permitted to be tapped at ¼ watt.
  - O. Mount outlet box for electric door holder to withstand 80 pounds (36.4 kg) pulling force.
- 3.4 PATHWAYS
- A. Pathways above suspended ceilings and in nonaccessible locations may be routed exposed where permitted by NFPA 70 & 72.
    - 1. Exposed pathways shall be:

- a. installed in conduit.
  - b. routed to minimize visibility.
  - c. routed parallel to main structural elements.
  - d. routed above the bottom of main structural elements.
  - e. painted to match surrounding finishes.
- B. All detection and control circuits associated with smoke control systems shall be fully enclosed within continuous raceways.
- C. Minimum allowable conduit size shall be  $\frac{3}{4}$  inch. The conduit shall be sized so that conduit fill does not exceed 75% of NFPA 70 maximum fill requirements. Cables in vertical risers shall not exceed 50% of NFPA 70 maximum fill requirements. Conduit installation shall be as required by the Contractor's layout and as described in these specifications. All conduit field routing shall be acceptable to the Owner. Routing not acceptable shall be rerouted and replaced without expense to the Owner.
- D. All wire, cable, conduit and raceways shall be concealed in walls, ceiling spaces, electrical shafts or closets in finished areas except as specifically noted otherwise. Conduit and raceways may be exposed in unfinished areas or where specifically approved by the Owner.
- E. Except as otherwise specified or indicated on the drawings, all conduit shall be installed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
- F. Conduit shall be located at least six inches from hot water or steam pipes, and from other hot surfaces. Conduit shall not block access to any existing equipment or fixtures.
- G. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit for conventional hardwired class B initiating and notification appliance circuits.
- H. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. Conduit shall enter cabinets from the bottom and sides only.

### 3.5 CONNECTIONS

- A. All wiring shall be terminated at devices or panels using terminal connectors for screw type terminals. All terminal connectors for conductors shall be pre-insulated ring type or pre-insulated spade type. Pre-insulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Pre-insulated terminal connectors shall include a metallic support sleeve bonded to the vinyl-insulating sleeve and designed to grip the conductor insulation.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Building security system for district monitoring.
  - 2. Provide equipment and connections to shutdown fan powered air distribution equipment with an individual capacity less than or equal to 2,000 cfm that are part of an air distribution system with a design capacity greater than 2,000 cfm.
  - 3. Magnetically held-open doors.
  - 4. Alarm initiating connection to elevator recall system and components.
  - 5. Connection to disable sound systems upon alarm activation.
  - 6. Supervisory connections at elevator shunt-trip breaker.

### 3.6 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

### 3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification as required by NFPA 70 and 72."
- B. All conduits and junction boxes shall be labeled as required by NFPA 70 and 72.
- C. The location of end-of-line resistors shall be identified with a label indicating "EOL."
- D. Provide label at each initiating device indicating the device address. Label shall be visible from the floor below or immediately adjacent to the device.

### 3.8 GROUNDING

- A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

### 3.9 FIELD QUALITY CONTROL

- A. Systems shall be checked and tested in accordance with the instructions provided by the manufacturer to insure that the system functions as required and is free of grounds, opens, and shorts. Each device shall be tested.
  - 1. Smoke detectors shall be tested with products of combustion.
- B. Upon completion of the system installation and before the Date of Final Acceptance, a factory-trained technician shall perform all necessary tests and adjustments and shall then file a Letter of Certification and a Certificate of Completion (NFPA 72) with the Owner indicating that the system functions and conforms to the Fire Alarm System Specifications.
- C. Upon completion of the system installation, a factory-trained technician shall perform all necessary tests and adjustments in the presence of the Owner's designated personnel. Test in accordance with NFPA 72 and requirements of the authority having jurisdiction. Perform the following tests at a minimum:
  - 1. Visual Inspection: Conduct visual inspection prior to testing. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
  - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    - a. Test audible appliances for the public operating mode according to manufacturer's written instructions.
    - b. Test visible appliances for the public operating mode according to manufacturer's written instructions.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire alarm system will be considered defective if it does not pass tests and inspections.
- F. Include services of factory trained and certified technician to supervise installation, adjustments, final connections, and system testing as performed by the fire alarm contractor's factory-trained technicians.

### 3.10 DEMONSTRATION

- A. The equipment supplier's factory trained technician shall train the Owner's personnel in the proper use and maintenance of the system. Training sessions shall be conducted as needed, not to exceed a total of 2 sessions, with each session lasting a maximum of 4 hours each.
- B. Demonstrate normal and abnormal modes of operation, and required responses to each.

END OF SECTION 284600

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