

# **PORT JERVIS CITY SCHOOL DISTRICT**

150 Pike Street  
Port Jervis, New York 12771

**Alterations to:  
Middle School (former Anna S. Kuhl ES) / High School  
& New Varsity Baseball / Softball Dugouts / Storage**

**SED Control No.'s:**

44-18-00-05-0-012-040 - Middle School / High School  
44-18-00-05-7-057-001 - New Varsity Baseball Dugout / Storage  
44-18-00-05-7-058-001 - New Varsity Softball Dugout / Storage

**BCA Project No. 2019-011 PH2**



**Bernier, Carr & Associates, Engineers,  
Architects and Land Surveyors, P.C.**  
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Set # \_\_\_\_\_

**VOLUME II OF II  
BIDDING DOCUMENTS AND TECHNICAL SPECIFICATIONS  
DIVISIONS 22, 23, 26-28 & 31 – 33**

The above signed Architect/Engineer certifies that, to the best of his knowledge, information and belief, the plans and specifications are in accordance with applicable requirements of the New York State Uniform Fire Prevention and Building Code, the State Energy Conservation Code, construction standards of the State Education Department, and Part 56 of Title 12 of the Official Compilation of Codes, Rules and Regulations of the State of New York.



**TABLE OF CONTENTS TO  
SPECIFICATION FOR**

**Port Jervis City School District  
Alterations to MS / HS & New Varsity  
Baseball / Softball Dugouts / Storage  
Project No. 2019-011 PH2**

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Volume I of II

**ALL CONTRACTORS**

Notice to Bidders  
Form of Proposal: Contract 1 – General Construction  
Form of Proposal: Contract 2 – Mechanical Construction  
Form of Proposal: Contract 3 – Plumbing Construction  
Form of Proposal: Contract 4 – Electrical Construction  
Form of Proposal: Contract 5 – Site Construction  
Form of Proposal: Contract 7 – Food Service  
Sample Agreement (A132-2019)  
General Conditions of the Contract for Construction (A232-2019)  
Statement of Special Inspections  
Submittal Form  
Wage Rate Schedule

**DIVISION 00 – PROCUREMENT REQUIREMENTS**

00 1001 Plan Deposit Policy  
00 2113 Information for Bidders

**DIVISION 01 – GENERAL REQUIREMENTS**

01 0000 General Requirements  
01 1000 Multiple Contract Summary  
01 1100 Milestone Schedule  
01 2000 Price and Payment Procedures  
01 2100 Allowances  
01 2200 Unit Prices  
01 3000 Administrative Requirements  
01 3300 Submittal Procedures  
01 3529.10 Life Safety Requirements During School Construction  
01 3553 Security Procedures  
01 4000 Quality Requirements  
01 4533 Code-Required Special Inspections and Procedures  
01 5000 Temporary Facilities and Controls  
01 5500 Vehicular Access and Parking  
01 5713 Erosion and Sediment Control  
01 5721 Indoor Air Quality Controls  
01 5813 Temporary Project Signage  
01 6000 Product Requirements  
01 6116 Volatile Organic Compound (VOC) Content Restrictions  
01 7000 Execution and Closeout Requirements  
01 7329 Cutting and Patching  
01 7800 Closeout Submittals  
01 7900 Demonstration and Training  
01 9113 General Commissioning Requirements

**TABLE OF CONTENTS TO  
SPECIFICATION FOR**

**Port Jervis City School District  
Alterations to MS / HS & New Varsity  
Baseball / Softball Dugouts / Storage  
Project No. 2019-011 PH2**

---

**DIVISION 02 – EXISTING CONDITIONS**

02 2600	Asbestos, Lead and PCB Assessment
02 4100	Demolition
02 8213	Asbestos Abatement
02 8313	Lead Abatement and Hazard Control Activities

**DIVISION 03 – CONCRETE**

03 1000	Concrete Forming and Accessories
03 2000	Concrete Reinforcing
03 3000	Cast-In-Place Concrete
03 3001	Concrete Sidewalks, Curbs and Exterior Concrete Flatwork

**DIVISION 04 – MASONRY**

04 0511	Masonry Mortaring and Grouting
04 2000	Unit Masonry

**DIVISION 05 – METALS**

05 1200	Structural Steel Framing
05 4000	Cold-Formed Metal Framing
05 5000	Metal Fabrications
05 5213	Pipe and Tube Railing

**DIVISION 06 – WOOD, PLASTICS, & COMPOSITES**

06 1000	Rough Carpentry
06 2000	Finish Carpentry

**DIVISION 07 – THERMAL AND MOISTURE PROTECTION**

07 2100	Thermal Insulation
07 5323	(EPDM) Thermoset Single-Ply Roofing
07 6100	Sheet Metal Roofing
07 8400	Firestopping
07 9200	Joint Sealants

**DIVISION 08 – OPENINGS**

08 1116	Aluminum Doors and Frames
08 1213	Hollow Metal Frames
08 1416	Flush Wood Doors
08 1743	Aluminum Hybrid Doors
08 7100	Door Hardware
08 8000	Glazing

**DIVISION 09 – FINISHES**

09 0561	Common Work Results for Flooring Preparation
09 2116	Gypsum Board Assemblies
09 2216	Non-Structural Metal Framing
09 3000	Tiling
09 5100	Acoustical Ceilings
09 5114	Acoustical Fabric-Faced Panel Ceilings
09 6500	Resilient Flooring
09 6623	Resinous Matrix Terrazzo Flooring
09 6813	Tile Carpeting

**TABLE OF CONTENTS TO  
SPECIFICATION FOR**

**Port Jervis City School District  
Alterations to MS / HS & New Varsity  
Baseball / Softball Dugouts / Storage  
Project No. 2019-011 PH2**

---

**DIVISION 09 – FINISHES (...Continued)**

09 7200	Wall Coverings
09 7800	Interior Wall Paneling
09 9000	Painting and Coating

**DIVISION 10 – SPECIALTIES**

10 1100	Visual Display Units
10 1400	Signage
10 1419	Dimensional Letter Signage
10 2113.19	Plastic Toilet Compartments
10 2600	Wall and Door Protection
10 2800	Toilet, Bath and Laundry Accessories
10 5113	Metal Lockers

**DIVISION 11 – EQUIPMENT**

11 3013	Residential Appliances
11 4000	Food Service Equipment

**DIVISION 12 – FURNISHINGS**

12 2400	Window Shades
12 3200	Manufactured Wood Casework
12 3216	Manufactured Plastic Laminate Casework
12 3553.19	Wood Laboratory Casework
12 3600	Countertops

**TABLE OF CONTENTS TO  
SPECIFICATION FOR**

**Port Jervis City School District  
Alterations to MS / HS & New Varsity  
Baseball / Softball Dugouts / Storage  
Project No. 2019-011 PH2**

---

**Volume II of II**

**DIVISION 22 – PLUMBING**

22 0510	Basic Plumbing Requirements
22 0516	Expansion Fittings and Loops for Plumbing Piping
22 0517	Sleeves and Sleeve Seals for Plumbing Piping
22 0519	Meters and Gauges for Plumbing Piping
22 0523	General- Duty Valves for Plumbing Piping
22 0529	Hangers and Supports for Plumbing Piping and Equipment
22 0553	Identification for Plumbing Piping and Equipment
22 0716	Plumbing Equipment Insulation
22 0719	Plumbing Piping Insulation
22 1005	Plumbing Piping
22 1006	Plumbing Piping Specialties
22 4000	Plumbing Fixtures

**DIVISION 23 – HEATING, VENTILATING, & AIR CONDITIONING**

23 0510	Basic Mechanical Requirements
23 0516	Expansion Fittings and Loops for HVAC Piping
23 0517	Sleeves and Sleeve Seal for HVAC Piping
23 0519	Meters and Gauges for HVAC Piping
23 0523	General-Duty Valves for HVAC Piping
23 0529	Hangars and Supports for HVAC Piping and Equipment
23 0553	Identification for HVAC Piping and Equipment
23 0593	Testing, Adjusting, and Balancing for HVAC
23 0713	Duct Insulation
23 0716	HVAC Equipment Insulation
23 0719	HVAC Piping Insulation
23 0800	Commissioning of HVAC
23 0923	Direct-Digital Control System for HVAC
23 2113	Hydronic Piping
23 2114	Hydronic Specialties
23 2213	Steam and Condensate Heating Piping

**DIVISION 23 – HEATING, VENTILATING, & AIR CONDITIONING (Continued)**

23 2214	Steam and Condensate Heating Specialties
23 3100	HVAC Ducts and Casings
23 3300	Air Duct Accessories
23 3423	HVAC Power Ventilators
23 3513	Dust Collection Systems
23 3700	Air Outlets and Inlets
23 4000	Air Cleaning Devices
23 7413	Packaged Outdoor Central Station Air Handling Units
23 8200	Convection Heating and Cooling Units
23 8216	Air Coils

**TABLE OF CONTENTS TO  
SPECIFICATION FOR**

**Port Jervis City School District  
Alterations to MS / HS & New Varsity  
Baseball / Softball Dugouts / Storage  
Project No. 2019-011 PH2**

---

**DIVISION 26 – ELECTRICAL**

26 0505	Selective Demolition for Electrical
26 0510	Basic Electrical Requirements
26 0526	Grounding and Bonding for Electrical Systems
26 0529	Hangers and Supports for Electrical Systems
26 0533.13	Conduit for Electrical Systems
26 0533.16	Boxes for Electrical Systems
26 0553	Identification for Electrical Systems
26 0923	Lighting Control Devices
26 2416	Panelboards
26 2726	Wiring Devices
26 2816.16	Enclosed Switches
26 5100	Interior Lighting
26 5600	Exterior Lighting

**DIVISION 27 – COMMUNICATIONS**

27 0511	Requirement for Communication Systems
27 0526	Grounding and Bonding for Communication Systems
27 0528	Interior Pathways
27 1000	Structured Cabling General Requirements
27 1500	Horizontal Cabling
27 5117	IP Public Address System
27 5313	GPS (Primex) Wireless Clock Systems

**DIVISION 28 – ELECTRONIC SAFETY AND SECURITY**

28 4600.02	Fire Detection, Alarm and Communication System
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**DIVISION 31 – EARTHWORK**

31 0000	Earthwork
31 1000	Site Clearing
31 2317	Site Trenching

**DIVISION 32 – EXTERIOR IMPROVEMENTS**

32 1216	Asphalt Paving
32 1825	Infield Skinned Paving
32 3113	Chain Link Fences and Gates
32 9230	Athletic Field Construction

**DIVISION 33 – UTILITIES**

33 0110.58	Disinfection of Water Utility Piping Systems
33 1416	Site Water Utility Distribution Piping
33 4000	Storm Drainage Utilities

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**SECTION 22 0510  
BASIC PLUMBING REQUIREMENTS**

**PART 1 GENERAL**

**1.01 WORK INCLUDED**

- A. Provide all labor, tools, materials, accessories, parts, transportation, taxes, and related items, essential for installation of the work and necessary to make work, complete, and operational. Provide new equipment and material unless otherwise called for. References to codes, specifications and standards called for in the specification sections and on the drawings mean, the latest edition, amendment and revision of such referenced standard in effect on the date of these Contract Documents.

**1.02 LICENSING**

- A. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
- B. Plumbing work shall be performed by, or under, the direct supervision of a licensed master plumber if so required by the local jurisdiction.
- C. The Contractor shall be responsible for reviewing the local jurisdiction requirements prior to bidding.

**1.03 PERMITS**

- A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges.

**1.04 CODE COMPLIANCE**

- A. Provide work in compliance with the following:
  - 1. The Building Code of New York State including The Fire Code; Property Maintenance Code; Plumbing Code, Mechanical Code and Fuel Gas Code; and The Energy Code of New York.
  - 2. New York State Department of Labor Rules and Regulations.
  - 3. Occupational Safety and Health Administration (OSHA).
  - 4. National Fuel Gas Code, NFPA 54.
  - 5. National Electrical Code, NFPA 70.
  - 6. Local Codes and Ordinances.
  - 7. Life Safety Codes, NFPA 101 (2000).
  - 8. New York Board of Fire Underwriters.
  - 9. New York State Education Department "Manual of Planning Standards".

**1.05 GLOSSARY**

- A. ACI                    American Concrete Institute
- B. AGA                    American Gas Association
- C. AGCA                    Associated General Contractors of America, Inc.
- D. AIA                    American Institute of Architects
- E. AISC                    American Institute of Steel Construction
- F. AFBMA                    Anti-Friction Bearing Manufacturer's Association
- G. AMCA                    Air Moving and Conditioning Association, Inc.
- H. ANSI                    American National Standards Institute
- I. ARI                    Air Conditioning and Refrigeration Institute
- J. ASHRAE                    American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.
- K. ASME                    American Society of Mechanical Engineers

- L. ASPE American Society of Plumbing Engineers
- M. ASTM American Society for Testing Materials
- N. FM Factory Mutual Insurance Company
- O. IBR Institute of Boiler & Radiation Manufacturers
- P. IEEE Institute of Electrical and Electronics Engineers
- Q. IRI Industrial Risk Insurers
- R. NYBFU New York Board of Fire Underwriters
- S. NEC National Electrical Code
- T. NEMA National Electrical Manufacturer's Association
- U. NESC National Electrical Safety Code
- V. NFPA National Fire Protection Association
- W. NYS/DEC New York State Department of Environmental Conservation
- X. NYSDOH New York State Department of Health
- Y. NYS/UFPBC New York State Uniform Fire Prevention and Building Code
- Z. OSHA Occupational Safety and Health Administration
- AA. SBI Steel Boiler Institute
- BB. SMACNA Sheet Metal and Air Conditioning Contractors National Association
- CC. UFPO Underground Facilities Protective Organization
- DD. UL Underwriter's Laboratories, Inc.

**1.06 DEFINITIONS**

- A. Acceptance Owner acceptance of the project from Contractor upon certification by Owner's Representative.
- B. Approval/Approved Written permission to use a material or system.
- C. As Called For Materials, equipment including the execution specified/shown in the Contract Documents.
- D. Code Requirements Minimum requirements.
- E. Concealed Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
- F. Design Equipment Refer to the article, Equipment Arrangements, and the article, Substitutions.
- G. Design Make Refer to the articles, Equipment Arrangements, and the article, Substitutions.
- H. Exposed Work not identified as concealed.
- I. Equal or Equivalent Equally acceptable as determined by Owner's Representative.
- J. Furnish Supply and deliver to installed location.
- K. Furnished by Others Receive delivery at job site or where called for and install.
- L. Inspection Visual observations by Owner's site Representative.
- M. Install Mount and connect equipment and associated materials ready for use.
- N. Labeled Refers to classification by a standards agency.

- O. Make Refers to the article, Equipment Arrangements, and the article, Substitutions.
- P. Or Approved Equal Approved equal or equivalent as determined by Owner's Representative.
- Q. Owner's Representative The Prime Professional.
- R. Prime Professional Architect or Engineer having a contract directly with the Owner for professional services.
- S. Provide Furnish, install, and connect ready for use.
- T. Relocate Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
- U. Replace Remove and provide new item.
- V. Review A general contractual conformance check of specified products.
- W. Roughing Pipe, duct, conduit, equipment layout and installation.
- X. Satisfactory As specified in contract documents.
- Y. Site Representative Owner's inspector or "Clerk of Works" at the work site.

**1.07 SHOP DRAWINGS/PRODUCT DATA/SAMPLES**

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of Project and Contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: Name of Project; name of Prime Professional; name of Prime Contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for: confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

**1.08 PROTECTION OF PERSONS AND PROPERTY**

- A. Contractor shall assume responsibility for construction safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature required to provide safe conditions for all workmen and site visitors.

**1.09 EQUIPMENT ARRANGMENTS**

- A. The Contract Documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturer's names are listed as acceptable makes. If Contractor elects to use one (1) of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger motors, feeders, breakers, and equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings, or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

## 1.10 CONTINUITY OF SERVICES

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and plumbing connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical/plumbing facilities or services.

## 1.11 UTILITY COMPANY SERVICES

- A. Make arrangements with the Owner's gas supplier for relocation of existing gas lines. Provide service to the building as required. Coordinate all activities between the Owner and supplier. The installation of the gas service shall comply with the published standards, including but not limited to NFPA 54 and NFPA 58. PAY ALL UTILITY SUPPLIER CHARGES; INCLUDE CHARGES IN THE BASE BID.

## 1.12 ROUGHING

- A. Due to small scale of Drawings, it's not possible to indicate all offsets, fittings, changes in elevation, interferences, etc. Make necessary changes in Contract Work, equipment locations, etc., as part of a contract to accommodate work to obstacles and interferences encountered. Before installing, verify exact location and elevations at work site. DO NOT SCALE plans. If field conditions, details, changes in equipment or shop drawing information require an important rearrangement, report same to Owner's Representative for review. Obtain written approval for all major changes before installing.
- B. Install work so that items both existing and new are operable and serviceable. Eliminate interference with removal of coils, motors, filters, belt guards and/or operation of doors. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Where Contractor could not reasonably be expected to find such trade interferences due to concealment in walls, ceiling or floors, such relocations will be done by Change Order, if not, included in contract work. Contractor shall relocate existing work in way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK SINCE FEW OF SUCH ITEMS CAN BE SHOWN. Provide new materials, including new piping and insulation for relocated work.
- C. Coordinate work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas (i.e., thermostat, fixture, and switch mounting heights, and equipment mounting heights). Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and plumbing drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, speakers, and other items. Do not rough-in contract work without reflected ceiling location plans.
- D. Before roughing for equipment furnished by Owner or in other Contracts, obtain from Owner and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. For equipment and connections provided in this contract, prepare roughing drawing as follows:
  - 1. Existing Equipment: Measure the existing equipment and prepare for installation in new location.
  - 2. New Equipment: Obtain equipment roughing drawings and dimensions, then prepare roughing-in-drawings. If such information is not available in time, obtain an acknowledgement in writing, then make space arrangements as required with Owner's Representative.

### 1.13 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades shall submit coordination drawings in the form of reproducible transparencies drawn at not less than 3/8 inch scale. Such drawings will be required throughout all areas for all trades. These drawings shall show resolutions of trade conflicts in congested areas. Mechanical equipment rooms shall be drawn early in coordination drawing process simultaneous with all other congested areas. Prepare Coordination Drawings as follows:
1. The HVAC Trade shall prepare the base plan Coordination Drawings showing all ductwork, all pertinent heating piping, and equipment. These drawings may be sepias of the required ductwork Shop Drawings. The drawings shall be coordinated with lighting fixtures, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Owner's Representative. Provide adjustments to exact size, location, and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of contract. Minor revisions need not be re-drawn.
  2. HVAC Contractor shall provide sepia transparencies and/or prints and submit the base plan to all major trades' Contractors.
  3. The Plumbing Trade shall draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.
  4. The Electrical Trade shall draft location of lighting fixtures, cable trays, and feeders over 1-1/2 inches on the base plan, indicating areas of conflict and suggested resolution.
  5. The General Contractor shall indicate areas of architectural/structural conflicts or obstacles and coordinate to suit the overall construction schedule.
  6. The General Contractor shall expedite all drawing work and coordinate to suit the overall construction schedule. He shall then review these drawings and compare them with the architectural, structural, equipment, and other drawings and determine that all of the work can be installed without interference. In the case of unresolved interferences, he shall notify the Owner's Representative. The Owner's Representative will then direct the various Contractors as to how to revise their drawings as required to eliminate installation interferences.
  7. If a given trade proceeds to resolving conflicts, then if necessary, that Trade shall change its work at no extra cost in order to permit others to proceed with a coordinated installation. Coordination approval will be given by areas after special site meetings involving all Trades.
- B. Coordination Drawings are intended for the respective Contractor's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these Contract Documents.

#### **1.14 REMOVAL WORK**

- A. Where existing equipment removals are called for, submit to Owner's Representative a complete list of all items that Owner wishes to retain that do not contain asbestos or PCB material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State, and Local laws requirements. Where equipment is called for to be relocated, contractor shall carefully remove, clean and recondition, then reinstall. Removal all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl space, and roof to determine the total Scope of Work. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

#### **1.15 EQUIPMENT AND MATERIAL INSTALLATION**

- A. Provide materials that meet the following minimum requirements:
  1. Materials shall have a flame spread rating of 25 or less and smoke developed rating of 50 or less, in accordance with NFPA 255.
  2. All equipment and material for which there is a listing service shall bear a UL label.
  3. Potable water systems and equipment shall be built according to AWWA Standards.
  4. Gas-fired equipment and system shall meet AGA Regulations and shall have AGA label.
  5. Electrical equipment and systems shall meet UL Standards and requirements of the NEC.

#### **1.16 CUTTING AND PATCHING**

- A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch any cut or abandoned holes left by removals of equipment, fixtures, etc. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

#### **1.17 PAINTING**

- A. Include painting for patchwork with color to match adjacent surfaces. Where color cannot be adequately matched, paint entire surface. Provide one (1) coat of primer and two (2) finish coats or as called for in the mechanical and electrical specifications. Refer to General Construction Specifications for additional information.

#### **1.18 CONCEALMENT**

- A. Conceal all Contract Work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

#### **1.19 CHASES**

- A. New Construction:
  1. Certain chases, recessed, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical and electrical trades work shall provide all other openings required for their Contract Work.

2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction work.
  3. Assume responsibility for correct and final location and size of such openings.
  4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.
  5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2 inch above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all work and equipment damaged during course of drilling. Firestop all unused sleeves.
  6. Provide angle iron frame where openings are required for Contract Work, unless provided by General Contractor.
- B. In Existing Buildings:
1. Drill holes for floor and/or roof slab openings.
  2. Multiple pipes smaller than 1 inch properly spaced and supported may pass through one (1) 6 inch or smaller diameter opening.
  3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2 inches above floors.
  4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

#### **1.20 FLASHING, SEALING, FIRE-STOPPING**

- A. See Specification Section 22 0515 - Plumbing Firestopping.

#### **1.21 SUPPORTS**

- A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For precast panels/planks and metal decks, support Mechanical/Electrical Work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two (2) or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

#### **1.22 ACCESS PANELS**

- A. Access panels shall be furnished by the Mechanical and Plumbing Trades and installed by General Contractor. Location and size shall be the responsibility of each trade. Bear cost of construction changes necessary due to improper information or failure to provide proper information in ample time. Access panels over 324 square inches shall have two (2) cam locks. Contractor shall provide proper frame and door type for various wall or ceiling finishes. Access panels shall be manufactured by Milcor, or approved equal. Provide General Contractor with a set of architectural black and white prints with size and approximate locations of access panels shown.

#### **1.23 CONCRETE BASES**

- A. Provide concrete bases for all floor-mounted equipment (unless otherwise noted). Provide 3,000 pound concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 inches high (unless otherwise indicated); shape and size to accommodate equipment. Set anchor bolts in sleeves before pouring and after anchoring and leveling, fill equipment bases with grout.

#### **1.24 PLUMBING EQUIPMENT CONNECTIONS**

- A. Contractor is responsible for draining, filling, venting, chemically treating and restarting any systems which are affected by work shown on the Contract Documents unless specifically noted otherwise.
- B. Provide roughing and final water, waste, vent, propane, etc., connections to all equipment. Provide loose key stops, sanitary "P" traps, tailpiece, adapters, gas cocks, and all necessary piping and fittings from roughing point to equipment. Provide installation of sinks, faucets, traps, tailpiece furnished by others. Provide continuation of piping and connection to equipment that is furnished by others. Provide relief valve discharge piping from equipment relief valves to point(s) of safe discharge.
- C. Provide as part of Plumbing Work valved water outlet adjacent to equipment requiring same. Provide equipment type floor drains, or drain hubs, adjacent to equipment.
- D. Install controls and devices furnished by others.
- E. Refer to Contract Documents for roughing schedules and equipment lists indicating scope of connections required.
- F. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, and wiring as required.
- G. Refer to Manufacturer drawings and specifications for requirements of kitchen equipment, laboratory equipment and special equipment. Verify connection requirements before bidding.

#### **1.25 STORAGE AND PROTECTION OF MATERIALS**

- A. Store materials on dry base, at least 6 inches above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
- B. Refer to "General Conditions of the Contract for Construction."

#### **1.26 FREEZING AND WATER DAMAGE**

- A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no charge in Contract, any such damage to equipment, systems, and building. Perform first season's winterizing in presence of Owner's operating staff.

#### **1.27 LUBRICATION CHART**

- A. Provide lubrication chart, 8-1/2 inch x 11 inch minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall in area of equipment. List all motors and equipment in Contract. Obtain and list necessary information by name/location of equipment, manufacturer recommended types of lubrication and schedule. Lubricate motors as soon as installed and perform lubrication maintenance until final acceptance. Plumbing Trade shall add Contract items to the chart provided by the heating trade or provide separate charts.

#### **1.28 OWNER INSTRUCTIONS**

- A. Before final acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct designated person on proper operation, and care of systems/equipment. Repeat instructions, if necessary. Obtain written acknowledgement from person instructed prior to final payment. Contractor is fully responsible for system until final acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. List under clear plastic, operating, maintenance, and starting precautions procedures to be followed by Owner for operating systems and equipment.

### **1.29 MAINTENANCE MANUALS**

- A. Prepare Instructions and Maintenance Portfolios. Include one copy of each of approved Shop Drawings, wiring diagrams, piping diagrams spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, summer-winter changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer representative and service agency for all major equipment items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for final acceptance.

### **1.30 RECORD DRAWINGS**

- A. The Contractor shall obtain at his expense one (1) set of Construction Contract Drawings including non-reproducible black and white prints and one (1) set of reproducible mylars for the purpose of recording record conditions.
- B. The Contractor shall perform all survey work required for the location and construction of the work and to record information necessary for completion of the record drawings. Record drawings shall show the actual location of the constructed facilities in the same manner as was shown on the bid drawings. All elevations and dimensions shown on the drawings shall be verified or corrected so as to provide a complete and accurate record of the facilities as constructed.
- C. It shall be the responsibility of the Contractor to mark each sheet of the non-reproducible drawings in pencil and to record thereon in a legible manner, any and all approved field changes and conditions as they occur. A complete file of approved field sketches, diagrams, and other changes shall also be maintained. At completion of the Work, each sheet of record prints, plus all approved field sketches and diagrams, shall be used in preparation of the mylar reproducible record drawings.
- D. Completed reproducible mylar drawings shall be certified as reflecting record conditions and submitted to the Engineer for approval.

### **1.31 ADDITIONAL ENGINEERING SERVICES**

- A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any monies owed to the Contractor.

### **1.32 FINAL INSPECTION**

- A. Upon completion of all punch list items, the Contractor shall provide a copy of the punch list back to the Engineer with each items noted as completed or the current status of the item. Upon receipt, the Engineer will schedule a final inspection.

### **1.33 ALL TRADES TEMPORARY HEAT**

- A. Refer to the Standard General Conditions of the Contract for Construction and Supplementary Conditions.

### **1.34 PLUMBING TEMPORARY FACILITIES**

- A. Refer to the Standard General Conditions of the Contract for Construction and Supplementary Conditions.

### **1.35 CLEANING**

- A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each Trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:
- B. Thoroughly clean entire installation, both exposed surfaces and interiors.
- C. Remove all debris caused by work.
- D. Remove tools, surplus, materials, when work is finally accepted.

**PART 2 PRODUCT - NOT USED**

**PART 3 EXECUTION - NOT USED**

**END OF SECTION**

**SECTION 22 0516  
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Flexible pipe connectors.

**1.02 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data:
  - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

**PART 2 PRODUCTS**

**2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING**

- A. Inner Hose: Carbon steel.
- B. Exterior Sleeve: Single braided, stainless steel.
- C. Pressure Rating: 125 psi and 450 degrees F.
- D. Joint: Flanged.
- E. Size: Use pipe sized units.
- F. Maximum offset: 3/4 inch on each side of installed center line.

**2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING**

- A. Inner Hose: Bronze.
- B. Exterior Sleeve: Braided bronze.
- C. Pressure Rating: 125 psi and 450 degrees F.
- D. Joint: Flanged.
- E. Size: Use pipe sized units.
- F. Maximum offset: 3/4 inch on each side of installed center line.
- G. Application: Copper piping.

**2.03 ACCESSORIES**

- A. Pipe Alignment Guides:
  - 1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- C. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

- D. Substitute grooved piping for vibration isolated equipment instead of flexible connectors.  
Grooved piping need not be anchored.

**END OF SECTION**

**SECTION 22 0517  
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 REFERENCE STANDARDS**

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2023a.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 6000 - Product Requirements, for additional provisions.

**1.04 QUALITY ASSURANCE**

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

**1.05 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

**PART 2 PRODUCTS**

**2.01 PIPE SLEEVES**

- A. Vertical Piping:
  - 1. Sleeve Length: 1 inch above finished floor.
  - 2. Provide sealant for watertight joint.
  - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
  - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- B. Pipe Passing Through Below Grade Exterior Walls:
  - 1. Zinc coated or cast iron pipe.
  - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- C. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
  - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
  - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Clearances:
  - 1. Provide allowance for insulated piping.
  - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
  - 3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

**2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS**

- A. Modular/Mechanical Seal:
  - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
  - 2. Provide watertight seal between pipe and wall/casing opening.

3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

#### **3.02 INSTALLATION**

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- E. Manufactured Sleeve-Seal Systems:
  1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
  2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
  3. Locate piping in center of sleeve or penetration.
  4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
  5. Tighten bolting for a water-tight seal.
  6. Install in accordance with manufacturer's recommendations.
- F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

**END OF SECTION**

**SECTION 22 0519  
METERS AND GAUGES FOR PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 REFERENCE STANDARDS**

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

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

**PART 2 PRODUCTS**

**2.01 PRESSURE GAUGES**

- A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
  - 1. Case: Steel with brass bourdon tube.
  - 2. Size: 4-1/2 inch diameter.
  - 3. Mid-Scale Accuracy: One percent.
  - 4. Scale: Psi and kPa.

**2.02 PRESSURE GAUGE TAPPINGS**

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

**2.03 STEM TYPE THERMOMETERS**

- A. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
  - 1. Size: 9 inch scale.
  - 2. Window: Clear Lexan.
  - 3. Accuracy: 2 percent, per ASTM E77.
  - 4. Calibration: Degrees F.

**2.04 STATIC PRESSURE GAUGES**

- A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. 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.

**END OF SECTION**

**SECTION 22 0523  
GENERAL-DUTY VALVES FOR PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 REFERENCE STANDARDS**

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- C. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves 2022.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- E. ASME B16.34 - Valves — Flanged, Threaded, and Welding End 2020.
- F. ASME B31.9 - Building Services Piping 2020.
- G. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- H. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- I. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- J. AWWA C606 - Grooved and Shouldered Joints 2022.
- K. MSS SP-67 - Butterfly Valves 2022.
- L. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.
- M. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
- N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
- O. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends 2011.
- P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
- Q. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- R. NSF 372 - Drinking Water System Components - Lead Content 2022.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

**PART 2 PRODUCTS**

**2.01 APPLICATIONS**

- A. Provide the following valves for the applications if not indicated on drawings:
  - 1. Shutoff: Ball, butterfly, plug.
  - 2. Throttling: Provide globe, angle, ball, or butterfly.

- B. Domestic, Hot and Cold Water Valves:
  - 1. 2 NPS and Smaller:
    - a. Bronze and Brass: Provide with solder-joint ends.
    - b. Ball: One piece, full port, brass with brass trim.
    - c. Bronze Swing Check: Class 125, bronze disc.
    - d. Bronze Globe: Class 125, bronze disc.
  - 2. 2-1/2 NPS and Larger:
    - a. Iron, 2-1/2 NPS to 4 NPS: Provide with threaded ends.
    - b. Iron Ball: Class 150.
    - c. Iron Single-Flange Butterfly: 200 CWP, EPDM seat, aluminum-bronze disc.
    - d. Iron Grooved-End Butterfly: 175 CWP.
    - e. Iron Swing Check: Class 125, metal seats.
    - f. Iron Grooved-End Swing Check: 300 CWP.
    - g. Iron Globe: Class 125.

## 2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
  - 1. Hand Lever: Quarter-turn valves 6 NPS and smaller except plug valves.
- D. Valve-End Connections:
  - 1. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
  - 2. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
  - 3. Solder Joint Connections: ASME B16.18.
  - 4. Grooved End Connections: AWWA C606.
- E. General ASME Compliance:
  - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
  - 2. Solder-joint Connections: ASME B16.18.
  - 3. Building Services Piping Valves: ASME B31.9.
- F. Potable Water Use:
  - 1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
  - 2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.

## 2.03 BRASS, BALL VALVES

- A. Two Piece, Full Port with Brass Trim and Soldered Connections:
  - 1. Comply with MSS SP-110.
  - 2. SWP Rating: 150 psig.
  - 3. CWP Rating: 600 psig, WOG.
  - 4. Body: Forged brass.
  - 5. Seats: PTFE.
  - 6. Ball: Chrome-plated brass.
- B. Two Piece, Full Port with Press Connection:
  - 1. CWP Rating: 250 psig, WOG.
  - 2. Body: Forged brass.
  - 3. Seats: EPDM.
  - 4. Ball: Chrome-plated brass.
  - 5. Blow-out Proof Stem: Forged brass.

6. Maximum Service Temperature: 250 deg F.

#### **2.04 IRON, BALL VALVES**

- A. Class 125, Full Port, Stainless Steel Trim:
  1. Comply with MSS SP-72.
  2. CWP Rating: 200 psig.
  3. Body: ASTM A536 Grade 65-45-12, ductile iron.
  4. Ends: Flanged.
  5. Seats: PTFE.
  6. Operator: Lever, with locking handle.

#### **2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES**

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

#### **2.06 IRON, GROOVED-END BUTTERFLY VALVES**

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

#### **2.07 BRONZE, SWING CHECK VALVES**

- A. General:
  1. Fabricate from dezincification resistant material.
  2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125 CWP Rating; 200 psig (1,380 kPa) WOG:
  1. Comply with MSS SP-80, Type 3.
  2. Design: Y-pattern, horizontal or vertical flow.
  3. Body: Bronze, ASTM B62.
  4. Ends: Threaded.
  5. Disc: Bronze.

#### **2.08 IRON, HORIZONTAL SWING CHECK VALVES**

- A. Class 125:
  1. Comply with MSS SP-71, Type I.
  2. CWP Rating: 200 psig.
  3. Design: Clear or full waterway.
  4. Body: ASTM A126, gray cast iron with bolted bonnet.
  5. Ends: Flanged.
  6. Trim: Composition.
  7. Seat Ring and Disc Holder: Bronze.
  8. Disc: PTFE.
  9. Gasket: Asbestos free.

## **2.09 IRON, GROOVED-END SWING CHECK VALVES**

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

## **2.10 BRONZE, GLOBE VALVES**

- A. General:
  - 1. Fabricate from dezincification resistant material.
  - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125: CWP Rating 200 psig:
  - 1. Comply with MSS SP-80, Type 1.
  - 2. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
  - 3. Ends: Threaded joint.
  - 4. Stem: Bronze.
  - 5. Disc: PTFE.
  - 6. Packing: Asbestos free.
  - 7. Handwheel: Malleable Iron.

## **2.11 IRON, GLOBE VALVES**

- A. Class 125: CWP Rating: 200 psig:
  - 1. Comply with MSS SP-85, Type I.
  - 2. Body: Gray iron; ASTM A126, with bolted bonnet.
  - 3. Ends: Flanged.
  - 4. Trim: Bronze.
  - 5. Packing and Gasket: Asbestos free.
  - 6. Operator: Handwheel or chainwheel.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

**END OF SECTION**

**SECTION 22 0529  
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 REFERENCE STANDARDS**

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping 2023.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2022).
- F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- H. MFMA-4 - Metal Framing Standards Publication 2004.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

**1.04 QUALITY ASSURANCE**

- A. Comply with applicable building code.

**PART 2 PRODUCTS**

**2.01 SUPPORT AND ATTACHMENT COMPONENTS**

- A. General Requirements:
  - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
  - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of \_\_\_\_\_. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

- B. Metal Channel (Strut) Framing Systems:
  - 1. Comply with MFMA-4.
- C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
  - 1. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Piping up to 1 inch (27 mm) nominal: 3/8 inch diameter.
    - b. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
- D. Pipe Stanchions: For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
  - 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
  - 2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- E. Beam Clamps: MSS SP-58 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.
- F. Riser Clamps:
  - 1. Provide copper plated clamps for copper tubing support.
  - 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- G. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
  - 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
  - 2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- H. Pipe Shields for Insulated Piping:
  - 1. General Construction and Requirements:
    - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
    - b. Shields Material: UV-resistant polypropylene with glass fill.
    - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
    - d. Minimum Service Temperature: Minus 40 degrees F.
    - e. Maximum Service Temperature: 178 degrees F.
    - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- I. Anchors and Fasteners:
  - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
  - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
  - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
  - 4. Hollow Masonry: Use toggle bolts.
  - 5. Hollow Stud Walls: Use toggle bolts.
  - 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
  - 7. Sheet Metal: Use sheet metal screws.
  - 8. Wood: Use wood screws.
  - 9. Plastic and lead anchors are not permitted.
  - 10. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    - a. Comply with MFMA-4.
    - b. Channel Material: Use galvanized steel.
    - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

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

**END OF SECTION**

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**SECTION 22 0553  
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 REFERENCE STANDARDS**

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

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION APPLICATIONS**

- A. Piping: Pipe markers.
- B. Pumps: Nameplates.
- C. Tanks: Nameplates.
- D. Valves: Tags and ceiling tacks where located above lay-in ceiling.

**2.02 NAMEPLATES**

- A. Description: Laminated three-layer plastic with engraved letters.
  - 1. Letter Color: White.
  - 2. Letter Height: 1/4 inch.
  - 3. Background Color: Black.
  - 4. Plastic: Comply with ASTM D709.

**2.03 TAGS**

- A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

**2.04 PIPE MARKERS**

- A. Comply with ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- 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.
- E. Color code as follows:
  - 1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.

## **2.05 CEILING TACKS**

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
  - 1. Plumbing Valves: Green.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

**END OF SECTION**

**SECTION 22 0716  
PLUMBING EQUIPMENT INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Covering.

**1.02 REFERENCE STANDARDS**

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- D. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- E. ASTM C1410 - Standard Specification for Cellular Melamine Thermal and Sound-Absorbing Insulation 2017 (Reapproved 2023).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

**1.04 DELIVERY, STORAGE, AND HANDLING**

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

**1.05 FIELD CONDITIONS**

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

**PART 2 PRODUCTS**

**2.01 REGULATORY REQUIREMENTS**

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

**2.02 CELLULAR MELAMINE**

- A. Insulation: Flexible preformed open-cell polymeric foam tubing, slit lengthwise for installation, complying with applicable requirements of ASTM C1410.
  - 1. K Value: ASTM C177; 0.25 at 75 degrees F.
  - 2. Minimum Service Temperature: Minus 40 degrees F.
  - 3. Maximum Service Temperature: 350 degrees F.

4. Density: 0.56 lb/cu ft.

### **2.03 GLASS FIBER, FLEXIBLE**

- A. Insulation: ASTM C553; flexible, noncombustible.
  1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
  2. Maximum Service Temperature: 450 degrees F.
  3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- B. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
  1. Secure with self-sealing longitudinal laps and butt strips.

### **2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION**

- A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
  1. Minimum Service Temperature: Minus 40 degrees F.
  2. Maximum Service Temperature: 220 degrees F.
  3. Connection: Waterproof vapor barrier adhesive.

### **2.05 JACKETS**

- A. PVC Plastic:
  1. Jacket: Sheet material, off-white color.
    - a. Minimum Service Temperature: Minus 40 degrees F.
    - b. Maximum Service Temperature: 150 degrees F.
    - c. Thickness: 10 mil.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install cellular melamine with factory-applied jackets with a manufacturer-approved adhesive along seams, both straight lap joints and circumferential lap joints.
- C. Inserts and Shields:
  1. Application: Equipment 1-1/2 inches diameter or larger.
  2. Shields: Galvanized steel between hangers and inserts.
  3. Insert location: Between support shield and equipment and under the finish jacket.
  4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- D. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

**END OF SECTION**

**SECTION 22 0719  
PLUMBING PIPING INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 07 8400 - Firestopping.
- B. Section 22 1005 - Plumbing Piping: Placement of hangers and hanger inserts.

**1.03 REFERENCE STANDARDS**

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.
- E. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2023).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

**PART 2 PRODUCTS**

**2.01 REGULATORY REQUIREMENTS**

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

**2.02 GLASS FIBER**

- A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
  - 1. K Value: ASTM C177, 0.23 at 75 degrees F.
  - 2. Maximum Service Temperature: 220 degrees F.
  - 3. Maximum Moisture Absorption: 0.2 percent by volume.

**2.03 JACKETS**

- A. PVC Plastic.
  - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
    - a. Minimum Service Temperature: 0 degrees F.
    - b. Maximum Service Temperature: 150 degrees F.

- c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
  - d. Thickness: 10 mil.
  - e. Connections: Brush on welding adhesive.
- B. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
  - C. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
    - 1. Thickness: 0.016 inch sheet.
    - 2. Finish: Smooth.
    - 3. Joining: Longitudinal slip joints and 2 inch laps.
    - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. Glass fiber insulated pipes conveying fluids below ambient temperature:
  - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
  - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. Glass fiber insulated pipes conveying fluids above ambient temperature:
  - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
  - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- G. Inserts and Shields:
  - 1. Application: Piping 1-1/2 inches diameter or larger.
  - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  - 3. Insert Location: Between support shield and piping and under the finish jacket.
  - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.
- I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- J. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

- K. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

**END OF SECTION**

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**SECTION 22 1005  
PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
  - 1. Sanitary sewer.
  - 2. Domestic water.
  - 3. Storm water.
  - 4. Flanges, unions, and couplings.
  - 5. Pipe hangers and supports.
  - 6. Ball valves.
  - 7. Balancing valves.

**1.02 RELATED REQUIREMENTS**

- A. Section 08 3100 - Access Doors and Panels.
- B. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.

**1.03 REFERENCE STANDARDS**

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- D. ASME B31.1 - Power Piping 2022.
- E. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
- F. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2022).
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- H. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings 2021.
- I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.
- J. ASTM B32 - Standard Specification for Solder Metal 2020.
- K. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes 2020.
- L. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.
- M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
- N. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube 2016.
- O. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings 2016.
- P. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.
- Q. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems 2020.
- R. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings 2020.

- S. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.
- T. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.
- U. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.
- V. AWWA C606 - Grooved and Shouldered Joints 2022.
- W. AWWA C651 - Disinfecting Water Mains 2014, with Addendum (2020).
- X. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).
- Y. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
- Z. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- AA. NSF 372 - Drinking Water System Components - Lead Content 2022.

#### **1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
- D. Project Record Documents: Record actual locations of valves.

#### **1.05 QUALITY ASSURANCE**

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

#### **1.07 FIELD CONDITIONS**

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

### **PART 2 PRODUCTS**

#### **2.01 GENERAL REQUIREMENTS**

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

#### **2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING**

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

- B. PVC Pipe: ASTM D2665 or ASTM D3034.
  - 1. Fittings: PVC.
  - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

### **2.03 SANITARY SEWER PIPING, ABOVE GRADE**

- A. Cast Iron Pipe: ASTM A74, service weight.
  - 1. Fittings: Cast iron.
  - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. PVC Pipe: ASTM D2729.
  - 1. Fittings: PVC.
  - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

### **2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING**

- A. Copper Pipe: ASTM B42, hard drawn.
  - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
  - 2. Joints: ASTM B32, alloy Sn95 solder.

### **2.05 DOMESTIC WATER PIPING, ABOVE GRADE**

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
  - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  - 2. Joints: ASTM B32, alloy Sn95 solder.
  - 3. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.

### **2.06 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING**

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
  - 1. Fittings: Cast iron.
  - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
  - 1. Fittings: PVC.
  - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

### **2.07 STORM WATER PIPING, ABOVE GRADE**

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
  - 1. Fittings: Cast iron.
  - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
  - 1. Fittings: PVC.
  - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

### **2.08 NATURAL GAS PIPING, ABOVE GRADE**

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
  - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
  - 2. Joints: Threaded or welded to ASME B31.1.

### **2.09 FLANGES, UNIONS, AND COUPLINGS**

- A. Unions for Pipe Sizes 3 inch and Under:
  - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
  - 2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.
- B. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
  - 1. Dimensions and Testing: In accordance with AWWA C606.

2. Housing Material: Provide ASTM A47/A47M malleable iron or ductile iron.
3. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
4. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
5. When pipe is field grooved, provide coupling manufacturer's grooving tools.

## **2.10 PIPE HANGERS AND SUPPORTS**

- A. Provide hangers and supports that comply with MSS SP-58.
  1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
  2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
  3. Trapeze Hangers: Welded steel channel frames attached to structure.
  4. Vertical Pipe Support: Steel riser clamp.
- B. Plumbing Piping - Drain, Waste, and Vent:
  1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
  2. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
  3. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
  4. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.
- C. Plumbing Piping - Water:
  1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
  2. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
  3. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.

## **2.11 BALL VALVES**

- A. Construction, 4 inch and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

## **2.12 BALANCING VALVES**

- A. Construction: Class 125, brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- B. Automatic Flow Limiting Cartridge with Ball Valve, Size 1/2 to 1 inch:
  1. Class 125, brass or bronze body, stainless steel cartridge, leak-proof stem, threaded or soldered connections with built-in union, dual PT (hot and cold pressure-temperature) test ports for 400 psi, 0.25 to 1.5 gpm WOG service.
- C. Calibration: Control flow within five percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

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

### **3.02 PREPARATION**

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

### **3.03 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 22 0516.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
  - 1. Coordinate size and location of access doors with Section 08 3100.
- I. Provide support for utility meters in accordance with requirements of utility companies.
- J. Install bell and spigot pipe with bell end upstream.
- K. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- L. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

### **3.04 APPLICATION**

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install globe valves for throttling, bypass, or manual flow control services.

### **3.05 TOLERANCES**

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/8 inch per foot slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

### **3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM**

- A. Prior to starting work, verify system is complete, flushed, and clean.
- B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

### **3.07 SCHEDULES**

- A. Pipe Hanger Spacing:
  - 1. Metal Piping:
    - a. Pipe Size: 1/2 inch to 1-1/4 inch:
      - 1) Maximum Hanger Spacing: 6.5 ft.
      - 2) Hanger Rod Diameter: 3/8 inches.
    - b. Pipe Size: 1-1/2 inch to 2 inch:

- 1) Maximum Hanger Spacing: 10 ft.
- 2) Hanger Rod Diameter: 3/8 inch.
- c. Pipe Size: 2-1/2 inch to 3 inch:
  - 1) Maximum Hanger Spacing: 10 ft.
  - 2) Hanger Rod Diameter: 1/2 inch.
- d. Pipe Size: 4 inch to 6 inch:
  - 1) Maximum Hanger Spacing: 10 ft.
  - 2) Hanger Rod Diameter: 5/8 inch.
- 2. Plastic Piping:
  - a. All Sizes:
    - 1) Maximum Hanger Spacing: 6 ft.
    - 2) Hanger Rod Diameter: 3/8 inch.

**END OF SECTION**

**SECTION 22 1006  
PLUMBING PIPING SPECIALTIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Drains.
- B. Cleanouts.
- C. Water hammer arrestors.
- D. Exterior penetration accessories.

**1.02 REFERENCE STANDARDS**

- A. ASME A112.6.3 - Floor and Trench Drains 2019.
- B. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- C. NSF 372 - Drinking Water System Components - Lead Content 2022.
- D. PDI-WH 201 - Water Hammer Arresters 2017.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

**1.04 QUALITY ASSURANCE**

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

**PART 2 PRODUCTS**

**2.01 GENERAL REQUIREMENTS**

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

**2.02 DRAINS**

- A. Floor Drains:
  - 1. Manufacturers:
    - a. Jay R. Smith Manufacturing Company: [www.jrsmith.com](http://www.jrsmith.com)
    - b. Zurn Industries, LLC: [www.zurn.com](http://www.zurn.com)
    - c. Watts; Model FD-100-A: [www.watts.com](http://www.watts.com).
    - d. Substitutions: See Section 01 6000 - Product Requirements.
- B. Floor Drain (FD-1):
  - 1. ASME A112.6.3; epoxy coated cast iron floor drain with anchor flange, weep holes, reversible clamping collar, and round, adjustable round heel proof nickel-bronze strainer.
- C. Floor Sink (FS-1):
  - 1. Type 304 Stainless Steel sanitary floor sink with loose set cast stainless steel grate, dome bottom strainer and no hub outlet.
  - 2. Manufacturers:
    - a. Watts: Model FS-780 [www.watts.com](http://www.watts.com).
    - b. Substitutions: See Section 01 6000 - Product Requirements.

**2.03 CLEANOUTS**

- A. Cleanouts at Interior Finished Floor Areas (CO-A):
  - 1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

#### **2.04 WATER HAMMER ARRESTORS**

- A. Water Hammer Arrestors:
  - 1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

#### **2.05 AIR VENTS**

- A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- B. Float Type:
  - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

#### **2.06 FLOOR DRAIN TRAP SEALS**

- A. Manufacturers:
  - 1. Green Drains; GD4: [www.greendrains.com](http://www.greendrains.com)
  - 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

#### **2.07 EXTERIOR PENETRATION ACCESSORIES**

- A. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for piping, cables, and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- B. Plumbing Ventilation Thru Roof Accessories - Retrofit:
  - 1. Plumbing Pipe Extension Kit: Extends roof plumbing pipes above minimum clearance from roof surface per local codes and Authority Having Jurisdiction (AHJ).

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Install floor cleanouts at elevation to accommodate finished floor.
- D. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks, washing machine outlets, or water closets.

**END OF SECTION**

**SECTION 22 4000  
PLUMBING FIXTURES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Water closets.
- B. Lavatories.
- C. Sinks.
- D. Washing Machine Outlet Box

**1.02 REFERENCE STANDARDS**

- A. ASME A112.19.2 - Ceramic Plumbing Fixtures 2018, with Errata.
- B. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- C. NSF 372 - Drinking Water System Components - Lead Content 2022.
- D. UL (DIR) - Online Certifications Directory Current Edition.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

**PART 2 PRODUCTS**

**2.01 GENERAL REQUIREMENTS**

- A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B. Water Efficiency: EPA WaterSense label is required for all water closets, urinals, lavatory faucets, and showerheads.

**2.02 REGULATORY REQUIREMENTS**

- A. Comply with applicable codes for installation of plumbing systems.
- B. Comply with UL (DIR) requirements.
- C. Perform work in accordance with local health department regulations.
- D. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

**2.03 FLUSH VALVE WATER CLOSETS**

- A. Water Closets (WC-2): Vitreous china, ASME A112.19.2, floor mounted, siphon jet flush action, china bolt caps.
  - 1. Flush Valve: Exposed (top spud).
  - 2. Flush Operation: Sensor operated.
  - 3. Color: White.
  - 4. Manufacturers:
    - a. American Standard, Inc: [www.americanstandard-us.com/](http://www.americanstandard-us.com/)
    - b. Kohler Company: [www.kohler.com/](http://www.kohler.com/)
    - c. Zurn Industries, Inc; Model Z5655-BWL1: [www.zurn.com/](http://www.zurn.com/)

- d. Substitutions: See Section 01 6000-Product Requirements.
- B. Water Closets (WC-2A (ADA height)): Vitreous china, ASME A112.19.2, floor mounted, siphon jet flush action, china bolt caps.
  - 1. Flush Valve: Exposed (top spud).
  - 2. Flush Operation: Sensor operated.
  - 3. Color: White.
  - 4. Manufacturers:
    - a. American Standard, Inc: [www.americanstandard-us.com/](http://www.americanstandard-us.com/)
    - b. Kohler Company: [www.kohler.com/](http://www.kohler.com/)
    - c. Zurn Industries, Inc; Model Z5665-BWL1: [www.zurn.com/](http://www.zurn.com/)
    - d. Substitutions: See Section 01 6000 - Product Requirements.
- C. Flush Valves: ASME A112.18.1, piston with debris screen and solenoid with self cleaning mechanism , complete with vacuum breaker stops and accessories.
  - 1. Sensor-Operated Type: Solenoid operator, battery powered, infrared sensor with mechanical over-ride or over-ride push button.
  - 2. Manufacturers:
    - a. Sloan Valve Company; Model 811-1.28-OR: [www.sloanvalve.com/](http://www.sloanvalve.com/)
    - b. Zurn Industries, Inc: [www.zurn.com/](http://www.zurn.com/)
    - c. Substitutions: See Section 01 6000 - Product Requirements.
- D. Seats:
  - 1. Manufacturers:
    - a. American Standard, Inc: [www.americanstandard-us.com/](http://www.americanstandard-us.com/)
    - b. Bemis Manufacturing Company: [www.bemismfg.com/](http://www.bemismfg.com/)
    - c. Church Seat Company; 295CT: [www.churchseats.com/](http://www.churchseats.com/)
    - d. Zurn Industries, Inc: [www.zurn.com/](http://www.zurn.com/)
    - e. Substitutions: See Section 01 6000 - Product Requirements.
  - 2. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, with cover.

#### **2.04 LAVATORIES (LAV-1A) (ADA)**

- A. Lavatory Manufacturers:
  - 1. American Standard, Inc; Model Decorum 9024.001EC: [www.americanstandard-us.com/](http://www.americanstandard-us.com/)
  - 2. Kohler Company: [www.kohler.com/](http://www.kohler.com/)
  - 3. Zurn Industries, Inc: [www.zurn.com/](http://www.zurn.com/)
  - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20 by 18 inch minimum, rectangular basin with splash lip, and rear overflow.
- C. Supply Faucet Manufacturers:
  - 1. American Standard, Inc: [www.americanstandard-us.com/](http://www.americanstandard-us.com/)
  - 2. Zurn Industries, Inc: [www.zurn.com/](http://www.zurn.com/)
  - 3. Chicago Faucets; Model EQ-A11C-23ABCP: [www.chicagofaucets.com](http://www.chicagofaucets.com).
  - 4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
  - 1. Spout Style: Standard.
  - 2. Power Supply: Battery, easily replaceable, lithium, minimum 200,000 cycles. Self-generating hydropowered Ecopower System.
  - 3. Mixing Valve: Built in ASSE 1070 Thermostatic Mixing Valve.
  - 4. Water Supply: 3/8 inch compression connections.
  - 5. Aerator: 0.5 GPM, laminar flow device.

6. Sensor range: Automatically adjusts.
7. Finish: Polished chrome.

## **2.05 LAVATORIES (LAV-2A) (ADA)**

- A. Manufacturers:
  1. Bradley; Model Terreon MF2944: [www.bradleycorp.com](http://www.bradleycorp.com)
  2. Substitutions: See Section 01 6000 - Product Requirements.
- B. General
  1. Size and Capacity
    - a. Accommodates 1–4 users at a time, using less water, energy and space than four lavs with conventional faucets. The pre-assembled sprayhead module is equipped with four independent streamformers, each controlled by a separate pushbutton or infrared sensor.
  2. Flow Control/Rate
    - a. Operating water pressure range is 20–80 psi. Flow regulators keep flow rate constant at all pressures. A flow restrictor keeps the flow rate constant under any pressure.
- C. Construction
  1. Bowl and Pedestal
    - a. Constructed of Terreon®, a densified solid surface material composed of bio-based resin, or Terreon®RE, a densified solid surface material composed of a bio-based resin and preconsumer recycled granules. Terreon and TerreonRE are resistant to chemicals, stains, burns, and impact. Surface damage can be easily repaired with everyday cleansers or fine grit abrasives. Terreon and TerreonRE are GREENGUARD® certified as low-emitting materials. Pedestal frame and access panels are constructed of heavy gauge type 300 Series stainless steel.
  2. Vandal Resistance
    - a. The molded sprayhead is an integral element of the bowl module. All streamformers and pushbuttons/infrared sensors are secured to the unit from inside the sprayhead module. All valving, water supplies, and waste connections are concealed inside the pedestal. The front access panel is removable only with a hex key. The Terreon and TerreonRE bowl are resistant to stains, burns, and impact, Surface damage is easily repaired and repair work is virtually undetectable.
  3. Valves and Fittings
    - a. In addition to the bowl and pedestal, the following valves and fittings are standard: Navigator® thermostatic mixing valve, stop valves, flexible stainless steel supply hoses, drain spud, and locknut. Stop valves mounted onto nominal copper tubing.
- D. Activation Type
  1. Battery Infrared
    - a. Each battery-powered sensor uses a zone-focused infrared transmitting beam, creating a large detection area not exceeding the bowl perimeter. The sensor is not affected by varying skin tones or darkness. When hands enter the detection area, the sensor starts water flow by opening the solenoid valve electronically. When hands leave the detection area, the sensor stops the flow of water by closing the valve. The 6VDC electronically activated solenoid valve has few moving parts, providing reliable operation that is unaffected by most chemicals and minerals often present in municipal water supplies. Each station is powered by a single lithium battery. Battery type is Duracell® DL 223A or equivalent (included). Battery type is Duracell® DL 223A 6V lithium or equivalent with a life expectancy of 4-5 years or approximately 200,000 cycles.

## **2.06 WASHING MACHINE OUTLET BOX (OB-1)**

- A. Manufacturers:
  1. Sioux Chief; Model 696-R2313MF: [www.siouxchief.com](http://www.siouxchief.com)

2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Fire Rated outlet boxes shall be used where necessary in plumbing supply/drainage systems. Unit shall allow for mounting with supply lines from top or bottom, mounted over stud or with one outlet box per stud cavity. Supply and drain boxes can be connected using provided galvanized U-Clip or separated as desired into individual stud cavities. Supply box can be inverted. Arrester variations can be installed with arresters at any angle. Unit shall be available with ¼-turn valves. Metal support bracket shall install into top/bottom tracks of box. Drain box shall have a ⅝" integral testable nipple on knockout. Outlet connections shall be generally ¾". Outlet connections should generally be provided with a test/tamper-resistant cap. Valves should be plated. Arrester option handles can be operated together (single throw) or independently.

## 2.07 SINKS (SK-1)

- A. Sink Manufacturers:
  1. American Standard, Inc: [www.americanstandard-us.com/](http://www.americanstandard-us.com/)
  2. Elkay; Model D22519: [www.elkay.com](http://www.elkay.com).
  3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Dual Compartment Bowl: ; 25 by 19 by 6-5/16 inch outside dimensions 22 gauge, 0.05 inch thick, Type 304 stainless steel, drop in.
  1. Drain: Two (2) 3-1/2 inch crumb cup and tailpiece.
- C. Supply Faucet Manufacturers:
  1. American Standard, Inc: [www.americanstandard-us.com](http://www.americanstandard-us.com)
  2. Zurn Industries, Inc: [www.zurn.com](http://www.zurn.com)
  3. Chicago Faucets; Model 527-317ABCP: [www.chicagofaucets.com](http://www.chicagofaucets.com)
  4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Manual Operated Faucet: Cast brass, chrome plated, deck mounted with 8" centers.
  1. Spout Style: 6-1/4" rigid/swing double-bend spout
  2. 4" vandal proof wristblade handles.
  3. Quarter turn compression operating cartridge
  4. Water Supply: 1/2 NPSM coupling nut for 1/2 flexible riser
  5. Full-flow outlet with single-screen design.

## 2.08 SINKS (SK-2)

- A. Sink Manufacturers:
  1. Best Sheet Metal; Model ADA-230S602056H: [www.bsmss.com](http://www.bsmss.com).
  2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Single Compartment Bowl: ; 60 by 20 by 6 inch outside dimensions 14 gauge, 0.0625 inch thick, Type 304 stainless steel, three station ADA free standing, with 1 1/2 drain hole.
  1. Drain: Solid Welded 1-1/2" NPT drain with 14 GA Stainless Steel perforated screen and tailpiece.
- C. Supply Faucet Manufacturers (3 faucets):
  1. American Standard, Inc: [www.americanstandard-us.com](http://www.americanstandard-us.com)
  2. Zurn Industries, Inc: [www.zurn.com](http://www.zurn.com)
  3. Chicago Faucets; Model W8W-L9E35-317ABCP: [www.chicagofaucets.com](http://www.chicagofaucets.com)
  4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Manual Faucet: 8" fixed Centers 8" rigid/swing gooseneck spout, chrome plated, wall mounted, 4" metal vandal-proof wristblade handles.
  1. Spout Style: 9-1/2in L-type swing spout
  2. Aerator: 1.5 GPM, laminar flow device.

## 2.09 SINKS (SK-3)

- A. Sink Manufacturers:
  - 1. Just Manufacturing Company; Model JPH-ADA-2230-CT: [www.justmfg.com](http://www.justmfg.com).
  - 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. ADA Compliant - Wall-Hung.
- C. Seamless welded construction of 16 gauge, type 304 stainless steel.
- D. Enclosure of 18 gauge, type 304 stainless steel.
- E. Interior and exposed exterior to have a satin blended No. 4
- F. Underside of sink to be sound deadening to insulate for sound and reduce condensation.
- G. Tapered front bowl wall provides greater ADA Compliant access.
- H. Support brackets of 14 ga. type 304 included. Wall clips included.
- I. JSL-46 Sensor faucet Battery Operated
- J. Thermostatic mixing valve.
- K. Emergency eyewash, swing down to operational position activating water Each head with top" dust cover, internal control. ANSI-compliant sign included. Tested and comply with ANSI Z358.1-2014
- L. In-line on eyewash and sensor faucets.
- M. Separate thermostatic mixing valves for eyewash and faucet.
- N. Eyewash mixing valve High Temp Limit set at 90 F (32 C). Outlet dial thermometer color coded to view temperature. Internal cold-water bypass on failure of hot water supply. Min. hot and cold supply 30 psi; max supply pressure 125 PSI. 2.0-9.0 GPM. 1/2" inlets with check and stop valves. Polished chrome plated brass construction with housing cover of type 316 stainless steel. ASSE 1071-2012 tested. Pre-piped enclosure connections to be completed at jobsite.
- O. Just J-35-SSF stainless steel grid drain, pre-installed.

## 2.10 SINKS (SK-4)

- A. Sink Manufacturers:
  - 1. American Standard, Inc: [www.americanstandard-us.com/](http://www.americanstandard-us.com/)
  - 2. Elkay; Model LRAD252165: [www.elkay.com](http://www.elkay.com).
  - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Single Compartment Bowl: ; 25 by 21-1/4 by 6-1/2 inch outside dimensions 18 gauge, 0.0625 inch thick, Type 304 stainless steel, drop in, with 3 1/2 drain hole.
  - 1. Drain: 3-1/2 inch crumb cup and tailpiece.
- C. Supply Faucet Manufacturers:
  - 1. American Standard, Inc: [www.americanstandard-us.com](http://www.americanstandard-us.com)
  - 2. Zurn Industries, Inc: [www.zurn.com](http://www.zurn.com)
  - 3. Chicago Faucets; Model 527-317ABCP: [www.chicagofaucets.com](http://www.chicagofaucets.com)
  - 4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Manual Faucet: 8" fixed Centers 8" rigid/swing gooseneck spout, chrome plated, deck mounted, 4" metal vandal-proof wristblade handles.
  - 1. Spout Style: 6-1/4in rigid/swing double-bend spout
  - 2. Water Supply: 1/2" NPSM supply inlets and coupling nut for 3/8 or 1/2 flexible riser.
  - 3. Single screen outlet for full flow.

## 2.11 SINKS (SK-5)

- A. Sink Manufacturers:
  - 1. American Standard, Inc: [www.americanstandard-us.com/](http://www.americanstandard-us.com/)

2. Elkay; Model LRAD171660: www.elkay.com.
  3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Single Compartment Bowl: ; 17 by 16 by 6inch outside dimensions 18 gauge, 0.0625 inch thick, Type 304 stainless steel, drop in, with 3 1/2 drain hole.
1. Drain: 3-1/2 inch crumb cup and tailpiece.
- C. Supply Faucet Manufacturers:
1. American Standard, Inc: www.americanstandard-us.com
  2. Zurn Industries, Inc: www.zurn.com
  3. Chicago Faucets; Model 527-317ABCP: www.chicagofaucets.com
  4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Manual Faucet: 8" fixed Centers 8" rigid/swing gooseneck spout, chrome plated, deck mounted, 4" metal vandal-proof wristblade handles.
1. Spout Style: 6-1/4in rigid/swing double-bend spout
  2. Water Supply: 1/2" NPSM supply inlets and coupling nut for 3/8 or 1/2 flexible riser.
  3. Single screen outlet for full flow.

## **2.12 SINKS (SK-6)**

- A. Sink Manufacturers: provided by casework manufacturer.
- B. Supply Faucet Manufacturers:
1. American Standard, Inc: www.americanstandard-us.com
  2. Zurn Industries, Inc: www.zurn.com
  3. Chicago Faucets; Model LWM2-B11-F: www.chicagofaucets.com
  4. Substitutions: See Section 01 6000 - Product Requirements.
- C. Manual Faucet: Deck mounted dual-inlet water faucet, 8" centers, 8" rigid/swing gooseneck spout with atmospheric vacuum breaker, 2-1/2" vandal proof cross handles with index button.
1. Spout Style: 8 in rigid/swing gooseneck spout
  2. Water Supply: 1/2" NPSM supply inlets and coupling nut for 3/8 or 1/2 flexible riser.
  3. Laboratory nozzle with 10 serrations for laboratory hose.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

### **3.02 PREPARATION**

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

### **3.03 INSTALLATION**

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports and bolts.

### **3.04 INTERFACE WITH WORK OF OTHER SECTIONS**

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

### **3.05 ADJUSTING**

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

### **3.06 CLEANING**

- A. Clean plumbing fixtures and equipment.

### **3.07 PROTECTION**

- A. Protect installed products from damage due to subsequent construction operations.
- B. Repair or replace damaged products before Date of Substantial Completion.

### **3.08 SCHEDULES**

- A. Fixture Heights: Install fixtures to heights above finished floor as indicated.
  - 1. Water Closet:
    - a. Standard: 15 inches to top of bowl rim.
    - b. Accessible: 18 inches to top of seat.
  - 2. Water Closet Flush Valves:
    - a. Standard: 11 inches min. above bowl rim.
  - 3. Lavatory:
    - a. Standard: 31 inches to top of basin rim.
    - b. Accessible: 34 inches to top of basin rim.
- B. Fixture Rough-In
  - 1. Water Closet (Flush Valve Type):
    - a. Cold Water: 1 Inch.
    - b. Waste: 4 Inch.
    - c. Vent: 2 Inch.
  - 2. Lavatory:
    - a. Hot Water: 1/2 Inch.
    - b. Cold Water: 1/2 Inch.
    - c. Waste: 1-1/2 Inch.
    - d. Vent: 1-1/4 Inch.
  - 3. Sink:
    - a. Hot Water: 1/2 Inch.
    - b. Cold Water: 1/2 Inch.
    - c. Waste: 1-1/2 Inch.
    - d. Vent: 1-1/4 Inch.

**END OF SECTION**

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**SECTION 23 0510  
BASIC MECHANICAL REQUIREMENTS**

**PART 1 GENERAL**

**1.01 WORK INCLUDED**

- A. Provide all labor, tools, materials, accessories, parts, transportation, taxes, and related items, essential for installation of the work and necessary to make work complete and operational. Provide new equipment and material unless otherwise called for. References to codes, specifications, and standards called for in the specification sections and on the drawings mean the latest edition, amendment, and revision of such referenced standard in effect on the date of these contract documents.

**1.02 LICENSING**

- A. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
- B. The Contractor shall be responsible for reviewing the local jurisdiction requirements prior to bidding.

**1.03 PERMITS**

- A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges.

**1.04 CODE COMPLIANCE**

- A. Provide work in compliance with the following:
  - 1. The Building Code of New York State including The Fire Code; Property Maintenance Code; Plumbing Code, Mechanical Code and Fuel Gas Code; and The Energy Code of New York.
  - 2. New York State Department of Labor Rules and Regulations.
  - 3. Occupational Safety and Health Administration (OSHA).
  - 4. National Fuel Gas Code, NFPA 54.
  - 5. National Electrical Code, NFPA 70.
  - 6. Local Codes and Ordinances.
  - 7. Life Safety Codes, NFPA 101 (2003).
  - 8. New York Board of Fire Underwriters.
  - 9. New York State Education Department "Manual of Planning Standards".
  - 10. Part 4 of Title 12 Rules and Regulations of the State of New York Industrial Code Rule No. 4 (12NYCRR4).

**1.05 GLOSSARY**

- A. AGA American Gas Association
- B. AIA American Institute of Architects
- C. AFBMA Anti-Friction Bearing Manufacturer's Association
- D. AMCA Air Moving and Conditioning Association, Inc.
- E. ANSI American National Standards Institute
- F. ARI Air Conditioning and Refrigeration Institute
- G. ASHRAE American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.
- H. ASME American Society of Mechanical Engineers
- I. ASPE American Society of Plumbing Engineers
- J. ASTM American Society for Testing Materials
- K. IBR Institute of Boiler & Radiation Manufacturers
- L. IEEE Institute of Electrical and Electronics Engineers

- M. NYBFU New York Board of Fire Underwriters
- N. NEC National Electrical Code
- O. NEMA National Electrical Manufacturer's Association
- P. NESC National Electrical Safety Code
- Q. NFPA National Fire Protection Association
- R. NYS/DEC New York State Department of Environmental Conservation
- S. SMACNA Sheet Metal and Air Conditioning Contractors National Association
- T. UFPO Underground Facilities Protective Organization
- U. UL Underwriter's Laboratories, Inc.
- V. OSHA Occupational Safety and Health Administration
- W. NYS/UFPBC New York State Uniform Fire Prevention and Building Code

### **1.06 DEFINITIONS**

- A. Acceptance: Owner acceptance of the project from Contractor upon certification by Owner's Representative.
- B. Approval/approved written permission to use a material or system.
- C. As Called for Materials: Equipment including the execution specified/shown in the contract documents.
- D. Code requirements: Minimum requirements.
- E. Concealed Work: Installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
- F. Design Equipment: Refer to the article, Equipment Arrangements, and the article, Substitutions.
- G. Design Make: Refer to the articles, Equipment Arrangements, and the article, Substitutions.
- H. Exposed Work not identified as concealed.
- I. Equal or Equivalent: Equally acceptable as determined by Owner's Representative.
- J. Furnish: Supply and deliver to installed location.
- K. Furnished by Others: Receive delivery at job site or where called for and install.
- L. Inspection: Visual observations by Owner's Site Representative.
- M. Install: Mount and connect equipment and associated materials ready for use.
- N. Labeled Refers to classification by a standards agency.
- O. Make: Refers to the article, Equipment Arrangements, and the article, Substitutions.
- P. Or Approved Equal: Approved equal or equivalent as determined by Owner's Representative.
- Q. Owner's Representative: The Prime Professional.
- R. Prime Professional: Architect or Engineer having a contract directly with the Owner for professional services.
- S. Provide: Furnish, install, and connect ready for use.
- T. Relocate: Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
- U. Replace: Remove and provide new item.
- V. Review: A general contractual conformance check of specified products.
- W. Roughing: Pipe, duct, conduit, equipment layout and installation.

- X. Satisfactory: As specified in contract documents.
- Y. Site Representative: Owner's inspector or "Clerk of Works" at the work site.

#### **1.07 SHOP DRAWINGS/PRODUCT DATA/SAMPLES**

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the Drawings and specifications. The Contractor is responsible for: confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.
- B. See Specification Section 01 3000 - Administrative Requirements for submittal procedures.

#### **1.08 PROTECTION OF PERSONS AND PROPERTY**

- A. Contractor shall assume responsibility for construction safety at all times and provide as part of Contract all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety features required to provide safe conditions for all workmen and site visitors.

#### **1.09 EQUIPMENT ARRANGEMENTS**

- A. The Contract Documents are prepared on basis of one (1) manufacturer as "design equipment," even though other manufacturer's names are listed as acceptable makes. If Contractor elects to use one (1) of the listed makes other than "design equipment," submit detailed Drawings, indicating proposed installation of equipment. Show maintenance arrangement. Make required changes in the Work of other trades, at no increase in any Contract. Provide larger motors, feeders, breakers, and equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings, or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to Contract Documents.

#### **1.10 CONTINUITY OF SERVICES**

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of Contract Work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical facilities or associated services.

## 1.11 ROUGHING

- A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, interferences, etc. Make necessary changes in Contract Work, equipment locations, etc., as part of a Contract to accommodate Work to obstacles and interferences encountered. Before installing, verify exact location and elevations at work site. DO NOT SCALE plans. If field conditions, details, changes in equipment or Shop Drawing information require an important rearrangement, report same to Owner's Representative for review. Obtain written approval for all major changes before installing.
- B. Install work so that items both existing and new are operable and serviceable. Eliminate interference with removal of coils, motors, filters, belt guards and/or operation of doors. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Where Contractor could not reasonably be expected to find such trade interferences due to concealment in walls, ceiling or floors, such relocations will be done by Change Order, if not, included in Contract Work. Contractor shall relocate existing work in way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK SINCE FEW OF SUCH ITEMS CAN BE SHOWN. Provide new materials, including new piping and insulation for relocated work.
- C. Coordinate Work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas (i.e., thermostat, fixture, and switch mounting heights, and equipment mounting heights). Coordinate all Work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical Drawings show design arrangement only for diffusers, grilles, registers, air terminals, and other items. Do not rough-in Contract Work without reflected ceiling location plans.
- D. Before roughing for equipment furnished by Owner or in other Contracts, obtain from Owner and other Contractors, approved Roughing Drawings giving exact location for each piece of equipment. Do not "rough in" services without Final Layout Drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. For equipment and connections provided in this Contract, prepare Roughing Drawing as follows:
  - 1. Existing equipment: Measure the existing equipment and prepare for installation in new location.
  - 2. New equipment: Obtain equipment roughing drawings and dimensions, then prepare roughing-in-drawings. If such information is not available in time, obtain an acknowledgement in writing, then make space arrangements as required with Owner's Representative.

## 1.12 REMOVAL WORK

- A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State, and Local law requirements. Where equipment is called for to be relocated, Contractor shall carefully remove, clean and recondition, then re-install. Removal all abandoned piping, equipment, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl space, and roof to determine the total Scope of Work. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

## 1.13 EQUIPMENT AND MATERIAL INSTALLATION

- A. Provide materials that meet the following minimum requirements:
1. Materials shall have a flame spread rating of 25 or less and smoke developed rating of 50 or less, in accordance with NFPA 255.
  2. All equipment and material for which there is a listing service shall bear a UL label.
  3. Gas-fired equipment and system shall meet AGA Regulations and shall have AGA label.
  4. Mechanical and electrical equipment and systems with electrical components shall be UL Listed and meet UL Standards and requirements of the NEC.

## 1.14 CUTTING AND PATCHING

- A. Mechanical trade shall include their required cutting and patching work unless shown as part of the General Construction Work on the Architectural Drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch any cut or abandoned holes left by removals of equipment, fixtures, etc. Patch adjacent existing Work disturbed by installation of new Work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

## 1.15 PAINTING

- A. Include painting for patchwork with color to match adjacent surfaces. Where color cannot be adequately matched, paint entire surface. Provide one (1) coat of primer and two (2) finish coats. Refer to General Construction Specifications for additional information.

## 1.16 CONCEALMENT

- A. Conceal all Contract Work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the Work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

## 1.17 CHASES

- A. New Construction:
1. Certain chases, recessed, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical Trade Work shall provide all other openings required for their Contract Work.
  2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction Work.
  3. Assume responsibility for correct and final location and size of such openings.

4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.
  5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2 inches above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all Work and equipment damaged during course of drilling. Firestop all unused sleeves.
  6. Provide angle iron frame where openings are required for Contract Work, unless provided by General Contractor.
- B. In Existing Buildings:
1. Drill holes for floor and/or roof slab openings.
  2. Multiple Pipes Smaller than 1 Inch: Properly spaced and supported may pass through one (1) 6 inch or smaller diameter opening.
  3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2 inches above floors.
  4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

#### **1.18 FLASHING, SEALING, FIRE-STOPPING**

- A. See Specification Section 07 8400 - Firestopping.

#### **1.19 SUPPORTS**

- A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support Contract Work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit Contract Work. If necessary in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support Mechanical/Electrical Work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting Contract Work. Mounting plates shall span two (2) or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

#### **1.20 ACCESS PANELS**

- A. Access panels shall be furnished by the Mechanical Trade and installed by General Contractor. Location and size shall be the responsibility of Mechanical Trade. Bear cost of construction changes necessary due to improper information or failure to provide proper information in ample time. Access panels over 324 square inches shall have two (2) cam locks. Contractor shall provide proper frame and door type for various wall or ceiling finishes. Access panels shall be equal to "Milcor" as manufactured by Inland Steel Products Co., Milwaukee, Wisconsin. Provide General Contractor with a set of architectural black and white prints with size and approximate locations of access panels shown.

#### **1.21 CONCRETE BASES**

- A. Provide concrete bases for all floor-mounted equipment (unless otherwise noted). Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 inches high (unless otherwise indicated); shape and size to accommodate equipment. Set anchor bolts in sleeves before pouring and after anchoring and leveling, fill equipment bases with grout.

#### **1.22 HVAC EQUIPMENT CONNECTIONS**

- A. Mechanical Contractor is responsible for draining, filling, venting, chemically treating and restarting any systems which are affected by work shown on the Contract Documents unless specifically noted otherwise.

- B. Provide final hydronic, steam, drain, vent, and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and rail connections extended to floor drains.
- C. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, as required.
- D. Refer to manufacturer drawings and specifications for requirements of kitchen equipment, laboratory equipment and special equipment. Verify connection requirements before bidding.

**1.23 DELIVERY**

- A. Accept materials delivered on site in manufacturer's packaging, labeled with manufacturer's identification and product information.

**1.24 STORAGE AND PROTECTION OF MATERIALS**

- A. Store materials on dry base, at least 6 inches above ground or floor. Store so as not to interfere with other Work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
- B. Maintain ambient conditions for each product as required by each manufacturer from time of delivery. Maintain appropriate ambient conditions for installation as recommended by each manufacturer for a minimum of 24 hours prior and 24 hours after installation.
- C. Refer to "General Conditions of the Contract for Construction."

**1.25 FREEZING AND WATER DAMAGE**

- A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no charge in contract, any such damage to equipment, systems, and building. Perform first seasons winterizing in presence of Owner's operating staff.

**1.26 LUBRICATION CHART**

- A. Provide lubrication chart, 8-1/2 inch x 11 inch minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall in area of equipment. List all motors and equipment in contract. Obtain and list necessary information by name/location of equipment, manufacturer recommended types of lubrication and schedule. Lubricate motors as soon as installed and perform lubrication maintenance until final acceptance. Plumbing trade shall add contract items to the chart provided by the heating trade or provide separate charts.

**1.27 OWNER INSTRUCTIONS**

- A. Before final acceptance of the Work, furnish necessary skilled labor to operate all systems by seasons. Instruct designated person on proper operation and care of systems/equipment. Repeat instructions, if necessary. Obtain written acknowledgement from person instructed prior to final payment. Contractor is fully responsible for system until final acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. List under clear plastic, operating, maintenance, and starting precautions procedures to be followed by Owner for operating systems and equipment.

### **1.28 MAINTENANCE MANUALS**

- A. Prepare Instructions and Maintenance Portfolios. Include one (1) copy of each of approved Shop Drawing, wiring diagram, piping diagram spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, summer-winter changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer representative and service agency for all major equipment items in a 3-ring binder with name of project on the cover. Deliver to Owner's Representative before request for final acceptance.

### **1.29 RECORD DRAWINGS**

- A. The Contractor shall obtain at his expense one (1) set of construction Contract Drawings including non-reproducible black and white prints and one (1) set of reproducible mylars for the purpose of recording record conditions.
- B. The Contractor shall perform all survey work required for the location and construction of the work and to record information necessary for completion of the Record Drawings. Record Drawings shall show the actual location of the constructed facilities in the same manner as was shown on the Bid Drawings. All elevations and dimensions shown on the Drawings shall be verified or corrected so as to provide a complete and accurate record of the facilities as constructed.
- C. It shall be the responsibility of the Contractor to mark each sheet of the non-reproducible drawings in pencil and to record thereon in a legible manner, any and all approved field changes and conditions as they occur. A complete file of approved field sketches, diagrams, and other changes shall also be maintained. At completion of the work, each sheet of record prints, plus all approved field sketches and diagrams shall be used in preparation of the mylar reproducible record drawings.
- D. Completed reproducible mylar Drawings shall be certified as reflecting record conditions and submitted to the Engineer for approval.

### **1.30 ADDITIONAL ENGINEERING SERVICES**

- A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any monies owed to the Contractor.

### **1.31 FINAL INSPECTION**

- A. Upon completion of all punch list items, the Contractor shall provide a copy of the punch list back to the Architect/Engineer with each item noted as completed or the current status of the item. Upon receipt, the Architect/Engineer will schedule a final inspection.

### **1.32 ALL TRADES TEMPORARY HEAT**

- A. Refer to the General Conditions of the Contract for Construction and Supplementary Conditions of the Contract for Construction.

### **1.33 HVAC MAINTENANCE OF SYSTEMS DURING TEMPORARY USE PERIODS**

- A. Provide each air handling system with a set of prefilters in addition to the permanent filters. Furnish four (4) sets of prefilters for each system for use when system is operated for temporary heating or cooling. During such use, change prefilters as often as directed by Owner's Representative. Provide necessary temporary throw away filters in all return openings to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply units only. Do not operate return fans.

- B. Blank-off outside air intake opening during temporary heating period. Install first set of permanent filters and prefilters.
- C. Adjust dampers on supply system.
- D. Set all heating coil control valves for manual operation.
- E. Do not install any grilles or diffusers at room terminal ends of ducts until permission is given.
- F. Assume responsibility for systems and equipment at all times, even though used for temporary heat or ventilating. Repair or replace all dented, scratched or damaged parts of systems prior to final acceptance.
- G. Remove concrete, rust, paint spots, other blemishes, then clean.
- H. Just prior to final acceptance, remove used final filter. Deliver all unused sets of prefilters to the Owner and obtain written receipt. Properly lubricate system bearings before and during temporary use. Maintain thermostats, freeze stats, overload devices, and all other safety controls in operating condition.

**1.34 CLEANING**

- A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this Contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises after all tests are made and installations completed satisfactorily:
- B. Thoroughly clean entire installation, both exposed surfaces and interiors.
- C. Remove all debris caused by work.
- D. Remove tools, surplus, materials, when work is finally accepted.

**1.35 SYSTEM START-UP AND TESTING**

- A. All new heating and ventilating shall be started up and operated at normal operating temperature for a period of 24 hours to "bake-off" the equipment. The associated ventilation system shall run on 100 percent outside air during the bake-off for an additional 8 hours to purge the building. This Work shall be completed prior to building occupancy or if the Work is not completed in time for summer "bake-off" on a Saturday with the Contractor responsible for being on-site during the entire purge and bake-off operation.
- B. Work of any Contract which includes system "bake-off", system start-up, system cut-over or staff training shall not be done 1 week prior to and 1 week after the opening of the building/addition except upon written approval by the Owner.
- C. Start-up of testing of HVAC systems shall occur while the building is not occupied by Owner and only after notice to the Project Inspector is made at least 24 hours in advance. The Mechanical Contractor shall be responsible for providing temporary filter media over all supply air registers and diffusers during the HVAC system start-up procedure. The Mechanical Contractor shall provide airtight plastic covers over all supply and return air openings prior to the start of construction by any Contractor. The plastic shall be maintained airtight throughout the project construction and removed only with the approval of the Project Inspector.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION - NOT USED**

**END OF SECTION**

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**SECTION 23 0516  
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets, and swing joints.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2300 - Refrigerant Piping.

**1.03 REFERENCE STANDARDS**

- A. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- B. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- C. EJMA (STDS) - EJMA Standards Tenth Edition.
- D. FM (AG) - FM Approval Guide Current Edition.
- E. UL (DIR) - Online Certifications Directory Current Edition.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data:
  - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- C. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.

**PART 2 PRODUCTS**

**2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING**

- A. Manufacturers:
  - 1. The Metraflex Company: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
- B. Inner Hose: Stainless Steel.
- C. Exterior Sleeve: Single braided, stainless steel.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: As Specified for Pipe Joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.

**2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING**

- A. Manufacturer:
  - 1. The Metraflex Company: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.

- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: As specified for pipe joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.

### **2.03 EXPANSION LOOPS - HOSE AND BRAID**

- A. Manufacturers:
  - 1. Flex-Weld, Inc; Keflex Ke-Loop: [www.flex-weld.com/#sle](http://www.flex-weld.com/#sle).
  - 2. The Metraflex Company; Metraloop: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
- B. Provide flexible loops with two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return with support bracket and air release or drain plug.
- C. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.
- D. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
  - 1. Maximum Allowable Working Pressure: 150 psig at 180 degrees F.
  - 2. Accommodate the Following:
    - a. Axial Deflection in Compression and Expansion:
    - b. Lateral Movement: 2 inch.
    - c. Angular Rotation: 15 degrees.
    - d. Force developed by 1.5 times specified maximum allowable operating pressure.
  - 3. End Connections: Same as specified for pipe jointing.
  - 4. Provide necessary accessories including, but not limited to, swivel joints.

### **2.04 ACCESSORIES**

- A. Pipe Alignment Guides:
  - 1. Manufacturers:
    - a. Flex-Weld, Inc: [www.flex-weld.com/#sle](http://www.flex-weld.com/#sle).
    - b. The Metraflex Company; PGQ Glide Riser Guide: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
  - 2. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
- B. Engineered Riser Anchor Clamps:
  - 1. Manufacturers:
    - a. The Metraflex Company; Engineered Riser Anchor Clamp: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
  - 2. Applications:
    - a. Provide one clamp to serve as a riser clip.
      - 1) Verify the total load of filled pipe to be supported will be a safety factor of one less than the maximum loading of the clamp per the manufacturer's instructions.
    - b. Provide one clamp above and one clamp below the slab to anchor pipe.
  - 3. Provide two piece, ductile iron in compliance with ASTM A536. Use with metal pipes with an outer diameter of 2.5 inches to 8 inches.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.

- D. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- E. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

**END OF SECTION**

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**SECTION 23 0517  
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 07 8400 - Firestopping.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment: Piping identification.
- C. Section 23 0719 - HVAC Piping Insulation.

**1.03 REFERENCE STANDARDS**

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

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

**PART 2 PRODUCTS**

**2.01 PIPE SLEEVES**

- A. Vertical Piping:
  - 1. Sleeve Length: 1 inch above finished floor.
  - 2. Provide sealant for watertight joint.
- B. Pipe Passing Through Exterior Walls:
  - 1. Zinc coated or cast iron pipe with asphalt coating.
  - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- C. Pipe Passing Through Mechanical Floors and walls:
  - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
  - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Clearances:
  - 1. Provide allowance for insulated piping.
  - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1-1/2 inch greater than external; pipe diameter.
  - 3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

**2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS**

- A. Manufacturers:
  - 1. Advance Products & Systems, LLC; Innerlynx: [www.apsonline.com/#sle](http://www.apsonline.com/#sle).

2. Flexicraft Industries; PipeSeal: [www.flexicraft.com/#sle](http://www.flexicraft.com/#sle).
- B. Modular/Mechanical Seal:
  1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
  2. Provide watertight seal between pipe and wall/casing opening.
  3. Elastomer element size and material in accordance with manufacturer's recommendations.
  4. Glass reinforced plastic pressure end plates.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

### **3.02 INSTALLATION**

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Structural Considerations:
  1. Do not penetrate building structural members unless indicated.
- E. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
  1. Aboveground Piping:
    - a. Pack solid using mineral fiber in compliance with ASTM C592.
    - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
  2. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
  3. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- F. Manufactured Sleeve-Seal Systems:
  1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
  2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
  3. Locate piping in center of sleeve or penetration.
  4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
  5. Tighten bolting for a water-tight seal.
  6. Install in accordance with manufacturer's recommendations.
- G. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

### **3.03 CLEANING**

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

- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

**END OF SECTION**

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**SECTION 23 0519  
METERS AND GAUGES FOR HVAC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 23 0923 - Direct-Digital Control System for HVAC.
- B. Section 23 2113 - Hydronic Piping.

**1.03 REFERENCE STANDARDS**

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

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

**PART 2 PRODUCTS**

**2.01 PRESSURE GAUGES**

- A. Manufacturers:
  - 1. Dwyer Instruments, Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  - 2. Moeller Instrument Company, Inc: [www.moellerinstrument.com/#sle](http://www.moellerinstrument.com/#sle).
  - 3. Omega Engineering, Inc: [www.omega.com/#sle](http://www.omega.com/#sle).
- B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
  - 1. Case: Steel with brass bourdon tube.
  - 2. Size: 4-1/2 inch diameter.
  - 3. Mid-Scale Accuracy: One percent.
  - 4. Scale: Psi.

**2.02 PRESSURE GAUGE TAPPINGS**

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

**2.03 STEM TYPE THERMOMETERS**

- A. Manufacturers:
  - 1. Dwyer Instruments, Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  - 2. Omega Engineering, Inc: [www.omega.com/#sle](http://www.omega.com/#sle).
  - 3. Weksler Glass Thermometer Corp: [www.wekslerglass.com/#sle](http://www.wekslerglass.com/#sle).

- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
  - 1. Size: 9 inch scale.
  - 2. Window: Clear Lexan.
  - 3. Stem: 3/4 inch NPT brass.
  - 4. Accuracy: 2 percent, per ASTM E77.
  - 5. Calibration: Degrees F.

#### **2.04 DIAL THERMOMETERS**

- A. Manufacturers:
  - 1. Dwyer Instruments, Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  - 2. Omega Engineering, Inc: [www.omega.com/#sle](http://www.omega.com/#sle).
  - 3. Weksler Glass Thermometer Corp: [www.wekslerglass.com/#sle](http://www.wekslerglass.com/#sle).
- B. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
  - 1. Size: 5 inch diameter dial.
  - 2. Lens: Clear glass.
  - 3. Accuracy: 1 percent.
  - 4. Calibration: Degrees F.

#### **2.05 THERMOMETER SUPPORTS**

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

#### **2.06 TEST PLUGS**

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

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. 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.
- D. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- E. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- F. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- G. Locate test plugs adjacent thermometers and thermometer sockets.

**END OF SECTION**

**SECTION 23 0523  
GENERAL-DUTY VALVES FOR HVAC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Applications.
- B. General requirements.
- C. Ball valves.
- D. Butterfly valves.
- E. Check valves.
- F. Chainwheels.

**1.02 RELATED REQUIREMENTS**

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 23 0719 - HVAC Piping Insulation.
- D. Section 23 2113 - Hydronic Piping.

**1.03 REFERENCE STANDARDS**

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- D. ASME B31.9 - Building Services Piping 2020.
- E. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- F. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2022).
- G. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- H. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- I. AWWA C606 - Grooved and Shouldered Joints 2022.
- J. MSS SP-45 - Drain and Bypass Connections 2020.
- K. MSS SP-67 - Butterfly Valves 2022.
- L. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.
- M. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
- N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
- O. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

## **1.05 QUALITY ASSURANCE**

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

## **1.06 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. Secure check valves in either the closed position or open position.
  - 5. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection and protect flanges and specialties from dirt.
    - a. Provide temporary inlet and outlet caps.
    - b. Maintain caps in place until installation.
  - 2. Store valves in shipping containers and maintain in place until installation.
    - a. Store valves indoors in dry environment.
    - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

## **PART 2 PRODUCTS**

### **2.01 APPLICATIONS**

- A. Provide the following valves for the applications if not indicated on drawings:
  - 1. Isolation (Shutoff): Butterfly and Ball.
  - 2. Swing Check (Pump Outlet):
    - a. 2 NPS and Smaller: Bronze with bronze disc.
    - b. 2-1/2 NPS and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
- B. 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 ends.
  - 2. Copper Tube:
    - a. 2 NPS and Smaller: Threaded ends (Exception: Solder-joint valve-ends).
    - b. 2-1/2 NPS and Larger: Grooved ends.
- C. Chilled Water Valves:
  - 1. 2 NPS and Smaller, Brass and Bronze Valves:
    - a. Threaded ends.
    - b. Ball: Full port, one piece, brass trim.
    - c. Swing Check: Bronze disc, Class.
  - 2. 2-1/2 NPS and Larger, Iron Valves:
    - a. Ball: 2-1/2 NPS to 10 NPS, Class 150.
    - b. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
    - c. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 175 CWP.
    - d. Swing Check: Metal seats, Class 125.
    - e. Grooved-End Check: 3 NPS to 12 NPS, 300 CWP.

- D. Heating Hot Water Valves:
  - 1. 2 NPS and Smaller, Brass and Bronze Valves:
    - a. Ball: Full port, one piece, brass trim.
    - b. Swing Check: Bronze disc, Class 125.
  - 2. 2-1/2 NPS and Larger, Iron Valves:
    - a. Ball: 2-1/2 NPS to 10 NPS, Class 150.
    - b. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
    - c. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 175 CWP.
    - d. Swing Check: Metal seats, Class 125.
    - e. Grooved-End Swing Check: 3 NPS to 12 NPS, 300 CWP.

## 2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
  - 1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
  - 2. Handwheel: Valves other than quarter-turn types.
  - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
  - 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.
- D. Valves in Insulated Piping: Provide 2 NPS stem extensions 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.
- E. Memory Stops: Fully adjustable after insulation is installed.
- F. Valve-End Connections:
  - 1. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
  - 2. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
  - 3. Solder Joint Connections: ASME B16.18.
  - 4. Grooved End Connections: AWWA C606.
- G. General ASME Compliance:
  - 1. 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.

## 2.03 BRASS BALL VALVES

- A. Two Piece, Full Port and Standard Port with Stainless Steel Trim:
  - 1. Comply with MSS SP-110.
  - 2. SWP Rating: 150 psig.
  - 3. Body: Forged brass.
  - 4. Ends: Threaded.

5. Seats: PTFE, TFE, or PTFE or TFE.
6. Stem: Stainless Steel.
7. Ball: Chrome-plated brass.
8. Manufacturers:
  - a. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).

#### **2.04 BRONZE BALL VALVES**

- A. Two Piece, Standard Port and Full Port with Bronze or Brass Trim:
  1. Comply with MSS SP-110.
  2. SWP Rating: 150 psig.
  3. Body: Bronze.
  4. Ends: Threaded.
  5. Seats: PTFE .
  6. Stem: Bronze or brass.
  7. Ball: Chrome plated brass.
  8. Manufacturers:
    - a. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).

#### **2.05 IRON, GROOVED-END BALL VALVES**

- A. Class 200:
  1. CWP Rating: 600 psig.
  2. Body: Ductile iron; ASTM A536, Grade 65-45-12.
  3. Ends: Grooved.
  4. Seats: Teflon.
  5. Stem: Nickel plated carbon steel.
  6. Ball: Type 304 stainless steel.

#### **2.06 IRON, SINGLE FLANGE BUTTERFLY VALVES**

- A. Lug type: Bi-directional dead end service without downstream flange.
  1. Comply with MSS SP-67, Type I.
  2. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
  3. Stem: One or two-piece stainless steel.
  4. Seat: NBR.
  5. Disc: Coated ductile iron.
  6. Manufacturers:
    - a. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).

#### **2.07 IRON, GROOVED-END BUTTERFLY VALVES**

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

#### **2.08 BRONZE LIFT CHECK VALVES**

- A. Class 125:
  1. CWP Rating: 200 psig.
  2. Design: Vertical flow.
  3. Body: Bronze.
  4. Ends: Threaded.
  5. Disc (Type 1): Bronze.

## 2.09 BRONZE SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa).
  - 1. Comply with MSS SP-80, Type 3.
  - 2. Body Design: Horizontal flow.
  - 3. Body Material: Bronze, ASTM B62.
  - 4. Ends: Threaded.
  - 5. Disc: Bronze.
  - 6. Manufacturers:
    - a. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).

## 2.10 IRON, FLANGED END SWING CHECK VALVES

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

## 2.11 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP:
  - 1. 10 NPS to 12 NPS.
  - 2. CWP Rating: 300 psig.
  - 3. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
  - 4. Disc: Ductile iron.
  - 5. Coating: Black, non-lead paint.

## 2.12 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. Attachment: For connection to butterfly valve stems.
  - 3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
  - 4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

## PART 3 EXECUTION

### 3.01 EXAMINATION

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

### 3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

- C. Provide chainwheels on operators for valves 4 NPS and larger where located 8 feet or more above finished floor, terminating 6 feet above finished floor.

**END OF SECTION**

**SECTION 23 0529  
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

**1.03 REFERENCE STANDARDS**

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

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
  - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
  - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
  - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
  - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

## 1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

## 1.06 QUALITY ASSURANCE

- A. Comply with applicable building code.

## 1.07 DELIVERY, STORAGE, AND HANDLING

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

## PART 2 PRODUCTS

### 2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
  - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
  - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 3. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  - 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
  - 1. Manufacturers:
    - a. Cooper B-Line, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
    - c. Unistrut, a brand of Atkore International Inc: [www.unistrut.com/#sle](http://www.unistrut.com/#sle).
    - d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
  - 2. Comply with MFMA-4.
  - 3. Channel Material:
    - a. Indoor Dry Locations: Use galvanized steel.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
  - 4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
  - 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
  - 1. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch diameter.

- b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
  - c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
  - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- D. Thermal Insulated Pipe Supports:
- 1. General Construction and Requirements:
    - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
    - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
    - c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes.
    - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
  - 2. PVC Jacket:
    - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
    - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
    - c. Thickness: 60 mil.
  - 3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.
- E. Pipe Supports:
- 1. Liquid Temperatures Up To 122 degrees F:
    - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
    - b. Support From Below: MSS SP-58 Types 35 through 38.
- F. Pipe Stanchions: For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
- 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
  - 2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- G. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
- 1. 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. Riser Clamps:
- 1. Provide copper plated clamps for copper tubing support.
  - 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- I. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- J. Strut Clamps: Two-piece pipe clamp.
- K. Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- L. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
- 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
  - 2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- M. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
- N. Nonpenetrating Rooftop Supports for Low-Slope Roofs:

1. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
  2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
  3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
  4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- O. Pipe Shields for Insulated Piping:
1. General Construction and Requirements:
    - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
    - b. Shields Material: UV-resistant polypropylene with glass fill.
    - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
    - d. Minimum Service Temperature: Minus 40 degrees F.
    - e. Maximum Service Temperature: 178 degrees F.
    - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- P. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
  2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
  3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
  4. Hollow Masonry: Use toggle bolts.
  5. Hollow Stud Walls: Use toggle bolts.
  6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
  7. Sheet Metal: Use sheet metal screws.
  8. Wood: Use wood screws.
  9. Plastic and lead anchors are not permitted.
  10. Powder-actuated fasteners are not permitted.
  11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    - a. Comply with MFMA-4.
    - b. Channel Material: Use galvanized steel.
    - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G. Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
  3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners according to manufacturer's recommended torque settings.
- J. Remove temporary supports.

**END OF SECTION**

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**SECTION 23 0553  
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 09 9123 - Interior Painting: Identification painting.

**1.03 REFERENCE STANDARDS**

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

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION APPLICATIONS**

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Control Panels: Nameplates.
- D. Dampers: Ceiling tacks, where located above lay-in ceiling.
- E. Ductwork: Nameplates.
- F. Heat Transfer Equipment: Nameplates.
- G. Piping: Tags.
- H. Pumps: Nameplates.
- I. Tanks: Nameplates.
- J. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- K. Water Treatment Devices: Nameplates.

**2.02 NAMEPLATES**

- A. Manufacturers:
  - 1. Seton Identification Products, a Tricor Direct Company: [www.seton.com/#sle](http://www.seton.com/#sle).
- B. Letter Color: White.
- C. Letter Height: 1/4 inch.
- D. Background Color: Black.

- E. Plastic: Comply with ASTM D709.

### **2.03 TAGS**

- A. Manufacturers:
  - 1. Advanced Graphic Engraving: [www.advancedgraphicengraving.com/#sle](http://www.advancedgraphicengraving.com/#sle).
  - 2. Kolbi Pipe Marker Co: [www.kolbipipemarkers.com/#sle](http://www.kolbipipemarkers.com/#sle).
  - 3. Seton Identification Products, a Tricor Company: [www.seton.com/#sle](http://www.seton.com/#sle).
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

### **2.04 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. Color: Yellow/Black.

### **2.05 STENCILS**

- A. Stencils: With clean cut symbols and letters of following size:
  - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
  - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
  - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
  - 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
  - 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
- B. Stencil Paint: As specified in Section 09 9123, semi-gloss enamel, colors complying with ASME A13.1.

### **2.06 PIPE MARKERS**

- A. Manufacturers:
  - 1. Kolbi Pipe Marker Co: [www.kolbipipemarkers.com/#sle](http://www.kolbipipemarkers.com/#sle).
  - 2. Seton Identification Products, a Tricor Company: [www.seton.com/#sle](http://www.seton.com/#sle).
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Color code as follows:
  - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

### **2.07 CEILING TACKS**

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
  - 1. HVAC Equipment: Yellow.
  - 2. Fire Dampers and Smoke Dampers: Red.

3. Heating/Cooling Valves: Blue.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 9123 for stencil painting.

#### **3.02 INSTALLATION**

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 09 9123.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Use tags on piping 3/4 inch diameter and larger.
  1. Identify service, flow direction, and pressure.
  2. Install in clear view and align with axis of piping.
  3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- H. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

**END OF SECTION**

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**SECTION 23 0593  
TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 01 9113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- B. Section 23 0800 - Commissioning of HVAC.

**1.03 REFERENCE STANDARDS**

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

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
  - 1. Include at least the following in the plan:
    - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
    - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
    - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
    - d. Final test report forms to be used.
    - e. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
  - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
  - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
  - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
  - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
  - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION**

**3.01 GENERAL REQUIREMENTS**

- A. Perform total system balance in accordance with one of the following:
  - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
  - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
  - 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. TAB Agency Qualifications:
  - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
  - 2. Certified by one of the following:
    - a. AABC, Associated Air Balance Council: [www.aabc.com/#sle](http://www.aabc.com/#sle); upon completion submit AABC National Performance Guaranty.
    - b. NEBB, National Environmental Balancing Bureau: [www.nebb.org/#sle](http://www.nebb.org/#sle).
    - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: [www.tabbcertified.org/#sle](http://www.tabbcertified.org/#sle).
- D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

**3.02 EXAMINATION**

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  - 1. Systems are started and operating in a safe and normal condition.
  - 2. Temperature control systems are installed complete and operable.
  - 3. Proper thermal overload protection is in place for electrical equipment.
  - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - 5. Duct systems are clean of debris.
  - 6. Fans are rotating correctly.
  - 7. Fire and volume dampers are in place and open.
  - 8. Air coil fins are cleaned and combed.
  - 9. Access doors are closed and duct end caps are in place.
  - 10. Air outlets are installed and connected.
  - 11. Duct system leakage is minimized.
  - 12. Hydronic systems are flushed, filled, and vented.
  - 13. Pumps are rotating correctly.
  - 14. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

**3.03 PREPARATION**

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

**3.04 ADJUSTMENT TOLERANCES**

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

**3.05 RECORDING AND ADJUSTING**

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. Check and adjust systems approximately six months after final acceptance and submit report.

**3.06 AIR SYSTEM PROCEDURE**

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions.

**3.07 WATER SYSTEM PROCEDURE**

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.

- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

### 3.08 COMMISSIONING

- A. See Sections 01 9113 - General Commissioning Requirements and 23 0800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
  - 1. Air side systems.
  - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 20 percent of the air handlers plus a random sample equivalent to 10 percent of the final TAB report data as directed by Commissioning Authority.
  - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
  - 2. Use the same test instruments as used in the original TAB work.
  - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
  - 4. For purposes of re-check, failure is defined as follows:
    - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
    - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
    - c. Temperatures: Deviation of more than one degree F.
    - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
    - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
  - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
  - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
  - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.

3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

### **3.09 SCOPE**

- A. Test, adjust, and balance the following:
  1. Plumbing Pumps.
  2. HVAC Pumps.
  3. Packaged Steel Fire Tube Boilers.
  4. Air Cooled Water Chillers.
  5. Packaged Roof Top Heating/Cooling Units.
  6. Computer Room Air Conditioning Units.
  7. Air Coils.
  8. Terminal Heat Transfer Units.
  9. Induction Units.
  10. Air Handling Units.
  11. Fans.
  12. Air Filters.
  13. Air Inlets and Outlets.

### **3.10 MINIMUM DATA TO BE REPORTED**

- A. Electric Motors:
  1. Manufacturer.
  2. Model/Frame.
  3. HP/BHP.
  4. Phase, voltage, amperage; nameplate, actual, no load.
  5. RPM.
  6. Service factor.
  7. Starter size, rating, heater elements.
  8. Sheave Make/Size/Bore.
- B. Pumps:
  1. Identification/number.
  2. Manufacturer.
  3. Size/model.
  4. Impeller.
  5. Service.
  6. Design flow rate, pressure drop, BHP.
  7. Actual flow rate, pressure drop, BHP.
  8. Discharge pressure.
  9. Suction pressure.
  10. Total operating head pressure.
  11. Shut off, discharge and suction pressures.
  12. Shut off, total head pressure.
- C. Combustion Equipment:
  1. Boiler manufacturer.
  2. Model number.
  3. Serial number.
  4. Firing rate.
  5. Overfire draft.

6. Gas pressure at meter outlet.
  7. Gas flow rate.
  8. Heat input.
  9. Burner manifold gas pressure.
  10. Percent carbon monoxide (CO).
  11. Percent carbon dioxide (CO<sub>2</sub>).
  12. Percent oxygen (O<sub>2</sub>).
  13. Percent excess air.
  14. Flue gas temperature at outlet.
  15. Ambient temperature.
  16. Net stack temperature.
  17. Percent stack loss.
  18. Percent combustion efficiency.
  19. Heat output.
- D. Chillers:
1. Identification/number.
  2. Manufacturer.
  3. Capacity.
  4. Model number.
  5. Serial number.
  6. Evaporator entering water temperature, design and actual.
  7. Evaporator leaving water temperature, design and actual.
  8. Evaporator pressure drop, design and actual.
  9. Evaporator water flow rate, design and actual.
- E. Cooling Coils:
1. Identification/number.
  2. Location.
  3. Service.
  4. Manufacturer.
  5. Air flow, design and actual.
  6. Entering air DB temperature, design and actual.
  7. Entering air WB temperature, design and actual.
  8. Leaving air DB temperature, design and actual.
  9. Leaving air WB temperature, design and actual.
  10. Water flow, design and actual.
  11. Water pressure drop, design and actual.
  12. Entering water temperature, design and actual.
  13. Leaving water temperature, design and actual.
  14. Air pressure drop, design and actual.
- F. Heating Coils:
1. Identification/number.
  2. Location.
  3. Service.
  4. Manufacturer.
  5. Air flow, design and actual.
  6. Water flow, design and actual.
  7. Water pressure drop, design and actual.
  8. Entering water temperature, design and actual.
  9. Leaving water temperature, design and actual.

10. Entering air temperature, design and actual.
  11. Leaving air temperature, design and actual.
  12. Air pressure drop, design and actual.
- G. Induction Units:
1. Manufacturer.
  2. Identification/number.
  3. Location.
  4. Model number.
  5. Size.
  6. Design air flow.
  7. Design nozzle pressure drop.
  8. Final nozzle pressure drop.
  9. Final air flow.
- H. Air Moving Equipment:
1. Location.
  2. Manufacturer.
  3. Model number.
  4. Serial number.
  5. Arrangement/Class/Discharge.
  6. Air flow, specified and actual.
  7. Return air flow, specified and actual.
  8. Outside air flow, specified and actual.
  9. Total static pressure (total external), specified and actual.
  10. Inlet pressure.
  11. Discharge pressure.
  12. Sheave Make/Size/Bore.
  13. Number of Belts/Make/Size.
  14. Fan RPM.
- I. Return Air/Outside Air:
1. Identification/location.
  2. Design air flow.
  3. Actual air flow.
  4. Design return air flow.
  5. Actual return air flow.
  6. Design outside air flow.
  7. Actual outside air flow.
  8. Return air temperature.
  9. Outside air temperature.
  10. Required mixed air temperature.
  11. Actual mixed air temperature.
  12. Design outside/return air ratio.
  13. Actual outside/return air ratio.
- J. Exhaust Fans:
1. Location.
  2. Manufacturer.
  3. Model number.
  4. Serial number.
  5. Air flow, specified and actual.
  6. Total static pressure (total external), specified and actual.

7. Inlet pressure.
  8. Discharge pressure.
  9. Sheave Make/Size/Bore.
  10. Number of Belts/Make/Size.
  11. Fan RPM.
- K. Duct Traverses:
1. System zone/branch.
  2. Duct size.
  3. Area.
  4. Design velocity.
  5. Design air flow.
  6. Test velocity.
  7. Test air flow.
  8. Duct static pressure.
  9. Air temperature.
  10. Air correction factor.
- L. Duct Leak Tests:
1. Description of ductwork under test.
  2. Duct design operating pressure.
  3. Duct design test static pressure.
  4. Duct capacity, air flow.
  5. Maximum allowable leakage duct capacity times leak factor.
  6. Test apparatus:
    - a. Blower.
    - b. Orifice, tube size.
    - c. Orifice size.
    - d. Calibrated.
  7. Test static pressure.
  8. Test orifice differential pressure.
  9. Leakage.
- M. Terminal Unit Data:
1. Manufacturer.
  2. Type, constant, variable, single, dual duct.
  3. Identification/number.
  4. Location.
  5. Model number.
  6. Size.
  7. Minimum static pressure.
  8. Minimum design air flow.
  9. Maximum design air flow.
  10. Maximum actual air flow.
  11. Inlet static pressure.

**END OF SECTION**

**SECTION 23 0713  
DUCT INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 23 0553 - Identification for HVAC Piping and Equipment.
- B. Section 23 3100 - HVAC Ducts and Casings: Glass fiber ducts.

**1.03 REFERENCE STANDARDS**

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

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

**1.05 DELIVERY, STORAGE, AND HANDLING**

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

## **PART 2 PRODUCTS**

### **2.01 REGULATORY REQUIREMENTS**

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

### **2.02 GLASS FIBER, FLEXIBLE**

- A. Manufacturer:
  - 1. CertainTeed Corporation: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
  - 2. Johns Manville: [www.jm.com/#sle](http://www.jm.com/#sle).
  - 3. Knauf Insulation: [www.knaufinsulation.com/#sle](http://www.knaufinsulation.com/#sle).
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
  - 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
  - 2. Maximum Service Temperature: 1200 degrees F.
  - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
  - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
  - 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
  - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

### **2.03 GLASS FIBER, RIGID**

- A. Manufacturer:
  - 1. CertainTeed Corporation: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
  - 2. Johns Manville: [www.jm.com/#sle](http://www.jm.com/#sle).
  - 3. Knauf Insulation: [www.knaufinsulation.com/#sle](http://www.knaufinsulation.com/#sle).
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
  - 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
  - 2. Maximum Service Temperature: 450 degrees F.
  - 3. Maximum Water Vapor Absorption: 5.0 percent.
  - 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
  - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
  - 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
  - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

### **2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION**

- A. Manufacturers:
  - 1. Aeroflex USA, Inc: [www.aeroflexusa.com/#sle](http://www.aeroflexusa.com/#sle).
  - 2. Armacell LLC: [www.armacell.us/#sle](http://www.armacell.us/#sle).
  - 3. K-Flex USA LLC: [www.kflexusa.com/#sle](http://www.kflexusa.com/#sle).
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
  - 1. Minimum Service Temperature: Minus 40 degrees F.

2. Maximum Service Temperature: 180 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

## **2.05 JACKETS**

A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

## **2.06 DUCT LINER**

A. Manufacturers:

1. Armacell LLC: [www.armacell.us/#sle](http://www.armacell.us/#sle).
2. CertainTeed Corporation: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
3. Johns Manville: [www.jm.com/#sle](http://www.jm.com/#sle).
4. Knauf Insulation: [www.knaufinsulation.com/#sle](http://www.knaufinsulation.com/#sle).

B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.

1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 180 degrees F.
3. Fungal Resistance: No growth when tested according to ASTM G21.
4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
5. Minimum Noise Reduction Coefficients:
  - a. 1 inch Thickness: 0.40.
6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm per ASTM C1071.
7. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.

D. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; rigid board and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.

1. Fungal Resistance: No growth when tested according to ASTM G21.
2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
3. Service Temperature: Up to 250 degrees F.
4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
5. Minimum Noise Reduction Coefficients:
  - a. 1 inch Thickness: 0.45.

E. Adhesive: Waterproof, fire-retardant type, ASTM C916.

F. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

A. Verify that surfaces are clean, foreign material removed, and dry.

### **3.02 INSTALLATION**

A. Install in accordance with manufacturer's instructions.

B. Insulated Ducts Conveying Air Below Ambient Temperature:

1. Provide insulation with vapor barrier jackets.
2. Finish with tape and vapor barrier jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

- C. Insulated Ducts Conveying Air Above Ambient Temperature:
  - 1. Provide with or without standard vapor barrier jacket.
  - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- E. External Duct Insulation Application:
  - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
  - 2. Secure insulation without vapor barrier with staples, tape, or wires.
  - 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
  - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
  - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- F. Duct and Plenum Liner Application:
  - 1. Adhere insulation with adhesive for 90 percent coverage.
  - 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
  - 3. Seal and smooth joints. Seal and coat transverse joints.
  - 4. Seal liner surface penetrations with adhesive.
  - 5. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.

### 3.03 SCHEDULES

- A. Exhaust Ducts within 10 Feet of Exterior Openings:
  - 1. Flexible Blanket: Ducts up to 18" wide.
    - a. Minimum Thickness: 2 inch.
    - b. Minimum R value: R-6.
    - c. Jacket Type: Vapor Barrier.
  - 2. Rigid Board: Ducts over 18" wide.
    - a. Minimum Thickness: 1-1/2 inches.
    - b. Minimum R value: R-6.
    - c. Jacket Type: Vapor Barrier.
- B. 100% Outside Air Ducts:
  - 1. Concealed inside building envelope in unconditioned spaces:
    - a. Flexible Blanket: Ducts up to 18" wide.
      - 1) Minimum Thickness: 2 inches.
      - 2) Minimum R value: R-6.
      - 3) Jacket Type: Vapor Barrier.
    - b. Rigid Board: Ducts over 18" wide.
      - 1) Minimum Thickness: 1-1/2 inches.
      - 2) Minimum R value: R-6.
      - 3) Jacket Type: Vapor Barrier.
  - 2. Exposed inside building envelope:
    - a. Rigid Board
      - 1) Minimum Thickness: 1-1/2 inches.
      - 2) Minimum R value: R-6.
      - 3) Jacket Type: Vapor Barrier.
- C. Air Conditioning Supply and Return; Heating Supply and Return:
  - 1. Concealed inside building envelope in unconditioned spaces:

- a. Flexible Blanket: Ducts up to 18" wide.
  - 1) Minimum Thickness: 2 inches.
  - 2) Minimum R value: R-6.
  - 3) Jacket Type: Vapor Barrier.
- b. Rigid Board: Ducts over 18" wide.
  - 1) Minimum Thickness: 1-1/2 inches.
  - 2) Minimum R value: R-6.
  - 3) Jacket Type: Vapor Barrier.
- 2. Exposed inside building envelope in unconditioned spaces and mechanical rooms:
  - a. Rigid Board
    - 1) Minimum Thickness: 1-1/2 inches.
    - 2) Minimum R value: R-6.
    - 3) Jacket Type: Vapor Barrier.
  - 3. Exposed inside building envelope in conditioned spaces:
    - a. Uninsulated unless otherwise indicated on Drawings.
  - 4. Inside building envelope, exposed to outside air (i.e., ventilated attic):
    - a. Flexible Blanket: Ducts up to 18" wide.
      - 1) Minimum Thickness: 4 inches.
      - 2) Minimum R value: R-12.
      - 3) Jacket Type: Vapor Barrier.
    - b. Rigid Board: Ducts over 18" wide.
      - 1) Minimum Thickness: 3 inches.
      - 2) Minimum R value: R-12.
      - 3) Jacket Type: Vapor Barrier.
- D. Duct Liner:
  - 1. Provide where shown on drawings.

**END OF SECTION**

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**SECTION 23 0716  
HVAC EQUIPMENT INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Equipment insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Covering.

**1.02 REFERENCE STANDARDS**

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- C. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation 2017 (Reapproved 2023).
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- F. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.
- G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

**1.04 DELIVERY, STORAGE, AND HANDLING**

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

**1.05 FIELD CONDITIONS**

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

## **PART 2 PRODUCTS**

### **2.01 REGULATORY REQUIREMENTS**

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

### **2.02 GLASS FIBER, FLEXIBLE**

- A. Manufacturers:
  - 1. CertainTeed Corporation: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
  - 2. Johns Manville Corporation: [www.jm.com/#sle](http://www.jm.com/#sle).
  - 3. Knauf Insulation: [www.knaufinsulation.com/#sle](http://www.knaufinsulation.com/#sle).
- B. Insulation: ASTM C553; flexible, noncombustible.
  - 1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
  - 2. Maximum Service Temperature: 450 degrees F.
  - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
  - 1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
  - 2. Secure with self-sealing longitudinal laps and butt strips.
  - 3. Secure with outward clinch expanding staples and vapor barrier mastic.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.

### **2.03 GLASS FIBER, RIGID**

- A. Manufacturer:
  - 1. CertainTeed Corporation: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
  - 2. Johns Manville Corporation: [www.jm.com/#sle](http://www.jm.com/#sle).
  - 3. Knauf Insulation: [www.knaufinsulation.com/#sle](http://www.knaufinsulation.com/#sle).
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
  - 1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
  - 2. Maximum Service Temperature: 850 degrees F.
  - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
  - 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
  - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
  - 3. Secure with self-sealing longitudinal laps and butt strips.
  - 4. Secure with outward clinch expanding staples and vapor barrier mastic.

### **2.04 HYDROUS CALCIUM SILICATE**

- A. Manufacturer:
  - 1. Johns Manville Corporation: [www.jm.com/#sle](http://www.jm.com/#sle).
- B. Insulation: ASTM C533; rigid molded, asbestos free, gold color.
  - 1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
  - 2. Maximum Service Temperature: 1200 degrees F.
  - 3. Density: 15 lb/cu ft.

## **2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION**

- A. Manufacturer:
  - 1. Aeroflex USA, Inc: [www.aeroflexusa.com/#sle](http://www.aeroflexusa.com/#sle).
  - 2. Armacell LLC: [www.armacell.us/#sle](http://www.armacell.us/#sle).
  - 3. K-Flex USA LLC: [www.kflexusa.com/#sle](http://www.kflexusa.com/#sle).
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
  - 1. Minimum Service Temperature: Minus 40 degrees F.
  - 2. Maximum Service Temperature: 220 degrees F.
  - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

## **2.06 JACKETS**

- A. PVC Plastic:
  - 1. Jacket: Sheet material, off-white color.
    - a. Minimum Service Temperature: Minus 40 degrees F.
    - b. Maximum Service Temperature: 150 degrees F.
    - c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
    - d. Thickness: 10 mil.
    - e. Connections: Brush on welding adhesive.
- B. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
  - 1. Lagging Adhesive: Compatible with insulation.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that surfaces are clean and dry, with foreign material removed.

### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated equipment containing fluids below ambient temperature; insulate entire system.
- G. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.
- H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- J. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

- K. Inserts and Shields:
  - 1. Application: Equipment 1-1/2 inches diameter or larger.
  - 2. Shields: Galvanized steel between hangers and inserts.
  - 3. Insert Location: Between support shield and equipment and under the finish jacket.
  - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- L. Finish insulation at supports, protrusions, and interruptions.
- M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

### **3.03 SCHEDULE**

- A. Heating Systems:
  - 1. Air Separators:
  - 2. Expansion Tanks:
  - 3. Hot Thermal Storage Tanks:
- B. Cooling Systems:
  - 1. Pump Bodies:
  - 2. Air Separators:
  - 3. Expansion Tanks:
  - 4. Chiller Cold Surfaces (Not Factory Insulated):

**END OF SECTION**

**SECTION 23 0719  
HVAC PIPING INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 23 2113 - Hydronic Piping: Placement of hangers and hanger inserts.
- B. Section 23 2300 - Refrigerant Piping: Placement of inserts.

**1.03 REFERENCE STANDARDS**

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation 2017 (Reapproved 2023).
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.
- H. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation 2022.
- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2023).
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- K. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- L. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).
- M. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2023).
- N. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials 2013 (Reapproved 2021).
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

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

### **1.05 DELIVERY, STORAGE, AND HANDLING**

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

### **1.06 FIELD CONDITIONS**

- A. Maintain ambient conditions required by manufacturers of each product.

## **PART 2 PRODUCTS**

### **2.01 REGULATORY REQUIREMENTS**

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

### **2.02 GLASS FIBER, RIGID**

- A. Manufacturers:
  - 1. CertainTeed Corporation: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
  - 2. Johns Manville Corporation: [www.jm.com/#sle](http://www.jm.com/#sle).
  - 3. Knauf Insulation: [www.knaufinsulation.com/#sle](http://www.knaufinsulation.com/#sle).
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
  - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
  - 2. Maximum Service Temperature: 850 degrees F.
  - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Indoor Vapor Barrier Finish:
  - 1. Cloth: Untreated; 9 oz/sq yd weight.
- F. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

### **2.03 CELLULAR GLASS**

- A. Pipe and Tubing Insulation: ASTM C552, Type II, Grade 6.
  - 1. K Value: 0.35 at 100 degrees F.
  - 2. Service Temperature Range: From 250 degrees F to 800 degrees F.
  - 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
  - 4. Water Absorption: 0.5 percent by volume, maximum.
  - 5. Density: A minimum of 6.12 lb/cu ft.
- B. Block Insulation: ASTM C552, Type I, Grade 6.
  - 1. K Value: 0.35 at 100 degrees F.
  - 2. Service Temperature: 800 degrees F, maximum.
  - 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
  - 4. Water Absorption: 0.5 percent by volume, maximum.

### **2.04 HYDROUS CALCIUM SILICATE**

- A. Manufacturers:
  - 1. Johns Manville Corporation: [www.jm.com/#sle](http://www.jm.com/#sle).
- B. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.

1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
2. Maximum Service Temperature: 1200 degrees F.
3. Density: 15 lb/cu ft.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

## **2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION**

A. Manufacturer:

1. Aeroflex USA, Inc; Aerocel Ultra-Low Perm (ULP): [www.aeroflexusa.com/#sle](http://www.aeroflexusa.com/#sle).
2. Armacell LLC; AP Armaflex: [www.armacell.us/#sle](http://www.armacell.us/#sle).
3. K-Flex USA LLC; K-Flex Titan: [www.kflexusa.com/#sle](http://www.kflexusa.com/#sle).

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.

1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 180 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

## **2.06 JACKETS**

A. PVC Plastic.

1. Manufacturers:
  - a. Johns Manville Corporation: [www.jm.com/#sle](http://www.jm.com/#sle).
2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
  - a. Minimum Service Temperature: 0 degrees F.
  - b. Maximum Service Temperature: 150 degrees F.
  - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
  - d. Thickness: 10 mil.
  - e. Connections: Brush on welding adhesive.
3. Covering Adhesive Mastic: Compatible with insulation.

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.

1. Thickness: 0.016 inch sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

## **2.07 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION**

A. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.

1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
  - a. Elastomeric Sleeve Diameter: 1-11/16 inch.
2. Outlet Cover Color: White.
3. Water Penetration: Comply with ASTM E331.
4. Air Leakage: Comply with ASTM E283.

B. Insulation Protection System: Refrigerant piping insulation PVC protective cover.

1. PVC Insulation Cover Color: White with full-length velcro fastener.
2. Weatherization and Ultraviolet Exposure Protection: Comply with ASTM G153.
3. Water/Vapor Permeability: Comply with ASTM E96/E96M.

4. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

### **PART 3 EXECUTION**

#### **3.01 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.

#### **3.02 INSTALLATION**

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

#### **3.03 SCHEDULE**

- A. Heating Systems:

1. Heating Water Supply and Return:
  2. Glycol Heating Supply and Return:
  3. Boiler Feed Water:
- B. Cooling Systems:
1. Chilled Water:
  2. Glycol Cooling Supply and Return:
  3. Condensate Drains from Cooling Coils:
  4. Refrigerant Suction:
  5. Refrigerant Hot Gas:

**END OF SECTION**

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**SECTION 23 0800  
COMMISSIONING OF HVAC**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.
- B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.
- D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
  - 1. Control system.
  - 2. Major and minor equipment items.
  - 3. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

**1.02 REFERENCE STANDARDS**

- A. ASHRAE Guideline 1.1 - HVAC&R Technical Requirements for the Commissioning Process 2007, with Errata (2012).

**1.03 SUBMITTALS**

- A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- C. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
  - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
  - 2. Full as-built set of control drawings.
  - 3. Full as-built sequence of operations for each piece of equipment.
  - 4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
    - a. Floor.
    - b. Room number.
    - c. Room name.
    - d. Air handler unit ID.
    - e. Reference drawing number.
    - f. Air terminal unit tag ID.
    - g. Heating and/or cooling valve tag ID.
    - h. Minimum air flow rate.
    - i. Maximum air flow rate.

5. Full print out of all schedules and set points after testing and acceptance of the system.
  6. Full as-built print out of software program.
  7. Electronic copy on disk of the entire program for this facility.
  8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
  9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
  10. Control equipment component submittals, parts lists, etc.
  11. Warranty requirements.
  12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
  13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
    - a. Sequences of operation.
    - b. Control drawings.
    - c. Points lists.
    - d. Controller and/or module data.
    - e. Thermostats and timers.
    - f. Sensors and DP switches.
    - g. Valves and valve actuators.
    - h. Dampers and damper actuators.
    - i. Program setups (software program printouts).
- D. Project Record Documents: See Section 01 7800 for additional requirements.
1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
  2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- E. Draft Training Plan: In addition to requirements specified in Section 01 7900, include:
1. Follow the recommendations of ASHRAE Guideline 1.1.
  2. Control system manufacturer's recommended training.
  3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- F. Training Manuals: See Section 01 7900 for additional requirements.
1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

## **PART 2 PRODUCTS**

### **2.01 TEST EQUIPMENT**

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

- B. Furnish additional information requested by the Commissioning Authority.
- C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.
- D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G. Provide temperature and pressure taps in accordance with Contract Documents.

### **3.02 INSPECTING AND TESTING - GENERAL**

- A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
- C. Provide two-way radios for use during the testing.
- D. Valve/Damper Stroke Setup and Check:
  1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
  2. Set pump/fan to normal operating mode.
  3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
  4. Command valve/damper open; verify position is full open and adjust output signal as required.
  5. Command valve/damper to a few intermediate positions.
  6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- E. Isolation Valve or System Valve Leak Check: For valves not by coils.
  1. With full pressure in the system, command valve closed.
  2. Use an ultra-sonic flow meter to detect flow or leakage.
- F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

### **3.03 TAB COORDINATION**

- A. TAB: Testing, adjusting, and balancing of HVAC.
- B. Coordinate commissioning schedule with TAB schedule.
- C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
- D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
- E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.

- F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

### **3.04 CONTROL SYSTEM FUNCTIONAL TESTING**

- A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
  - 1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
  - 2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
  - 1. Setpoint changing features and functions.
  - 2. Sensor calibrations.
- G. Demonstrate to the Commissioning Authority:
  - 1. That all specified functions and features are set up, debugged and fully operable.
  - 2. That scheduling features are fully functional and setup, including holidays.
  - 3. That all graphic screens and value readouts are completed.
  - 4. Correct date and time setting in central computer.
  - 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
  - 6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
  - 7. Power failure and battery backup and power-up restart functions.
  - 8. Global commands features.
  - 9. Security and access codes.
  - 10. Occupant over-rides (manual, telephone, key, keypad, etc.).
  - 11. O&M schedules and alarms.
  - 12. Occupancy sensors and controls.
  - 13. All control strategies and sequences not tested during controlled equipment testing.
- H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

### **3.05 OPERATION AND MAINTENANCE MANUALS**

- A. See Section 01 7800 for additional requirements.
- B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

### **3.06 DEMONSTRATION AND TRAINING**

- A. See Section 01 7900 for additional requirements.
- B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- E. TAB Review: Instruct Owner's personnel for minimum 4 hours, after completion of TAB, on the following:
  - 1. Review final TAB report, explaining the layout and meanings of each data type.
  - 2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
  - 3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
  - 4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
  - 5. Other salient information that may be useful for facility operations, relative to TAB.
- F. HVAC Control System Training: Perform training in at least three phases:
  - 1. Phase 1 - Basic Control System: Provide minimum of 4 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
    - a. This training may be held on-site or at the manufacturer's facility.
    - b. If held off-site, the training may occur prior to final completion of the system installation.
    - c. For off-site training, Contractor shall pay expenses of up to two attendees.
  - 2. Phase 2 - Integrating with HVAC Systems: Provide minimum of 4 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
    - a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
    - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.

- c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
  - d. Every display screen, allowing time for questions.
  - e. Point database entry and modifications.
3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of 4 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- G. Provide the services of manufacturer representatives to assist instructors where necessary.
- H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

**END OF SECTION**

**SECTION 23 0923  
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

**PART 1 GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. This specification is intended for reference only. The Owner will furnish all Invensys Climate Control (aka Schneider Electric: IA Series), control devices and wiring that is included in this section by OGS/GSA contract. The Mechanical Contractor will be responsible for contracting with the temperature controls provider for wiring, programming, commissioning, etc. The Mechanical Contractor shall also be responsible for installing control components in the piping and duct work systems, such as but not excluding the following: Automatic Control Dampers, Automatic Control Valves, Temperature Sensing Thermal Wells and Pressure Control Sensing Taps The Temperature Controls Contractor (TCC) shall be a factory trained and authorized Invensys Climate Control, Dealer Office. (Stark "TBS Controls")
1. This project is a design make Invensys Climate Control System. See section 2.1 of this specification for Acceptable Manufacturers.
  2. Furnish all labor, materials, equipment, and service necessary to provide a complete and operating temperature control system. System shall use Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein. Control sequences are specified in this section.
    - a. All actuation of valves and dampers shall be electric unless specifically called out elsewhere in the specifications or drawings.
  3. The Building Automation System (BAS) shall have the following capabilities as described in these specifications:
    - a. The Network Control Units (NCU)(s) and Computer(s) shall be connected directly to the Owners Ethernet Network.
    - b. If existing, off site access for Owner's personnel shall be extended to include new work herein. Identical graphical displays shall be provided for offsite access to match the displays at the on-site Operator Workstation. Connection to the site shall be via a high speed Ethernet connection. The contractor shall coordinate with the Owners IT professionals for high speed system access and shall comply with Owners requirements to maintain the level of security required by the Owner.
    - c. The BMS network controller shall integrate into the existing Invensys Climate Control server.
    - d. All system variables in the BMS system shall be Microsoft variables allowing them to be display and manipulated in other Microsoft products.
    - e. Network controllers shall all be flash upgradeable and not require changing chips for upgrades.
    - f. Short term logging of historical data shall be provided for every DDC input and output in the system. Each point shall be logged for a minimum of 2 weeks.
- B. **QUALITY ASSURANCE**
1. All labor, material, equipment and software necessary to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be provided by one of the manufacturers listed in Part 2 - Products. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner. This contractor also is responsible for all costs of changes in the work required by substitute equipment.

2. The Building Management System (BMS) Contractor must have been in business for not less than 10 years, and providing BMS systems must be the Contractors primary business. BMS Contractor must be an authorized dealer office of the manufacturers specified. BMS Contractor must have a trained staff of application engineers, project managers, software engineers, commissioning staff, and service staff experienced in the configuration, programming and service of the automation system.
3. The BMS Contractor shall have a training facility with regularly scheduled training as outlined in Section 1.4 so as to provide ongoing regularly scheduled application training.
4. Manufacturer: A firm regularly engaged in manufacture of microprocessor temperature control equipment, of types and sizes which are similar to required equipment, and which have been in satisfactory use for not less than 10 years, in similar service.
5. Electrical standards: Provide electrical products that comply with the following agency approvals:
  - a. UL-916; Energy Management Systems for BAS components and ancillary equipment
  - b. UL-873; Temperature Indication and Regulating Equipment
  - c. FCC, Part 15, Subpart J, Class A Computing Devices
6. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

C. SCOPE OF WORK

1. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators and other accessory equipment, along with a complete system of electrical interlocking wiring as required to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
2. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
3. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor shall review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system to the Owner and prove that it complies with the intent of the drawings and specifications.
  - a. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification.
4. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative. Commissioning reports showing the testing of each DDC point on the system shall be submitted to the Engineer for review and approval upon completion of the commissioning process. See Section 3.6 Commissioning and System Startup section for detail.
5. All work performed under this section of the specifications shall comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project for code compliance. If this specification and associated drawings exceed governing code requirements, the specification shall govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.
6. All 120V power circuitry required for control devices shall be by the BAS contractor in accordance with DIVISION 26 specifications.

D. TRAINING

1. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel per the following description:
  - a. On-site training shall consist of a minimum of (4) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:
    - 1) System Overview
    - 2) System Software and Operation
      - (a) System access
      - (b) Software features overview
      - (c) Changing setpoints and other attributes
      - (d) Scheduling
      - (e) Editing programmed variables
      - (f) Displaying color graphics
      - (g) Running reports
      - (h) Workstation maintenance
      - (i) Application programming
    - 3) Operational sequences including start-up, shutdown, adjusting and balancing.
    - 4) Equipment maintenance.
  2. Classroom training shall include a minimum of (1) training slot for two days of course material covering workstation operation and controller programming. The cost for travel and lodging shall be included in this contract if Training Center is more than 150 miles from the Project Site.
  3. The training facility shall have the capability to provide hands on training experience for all applications that can be run on the Invensys Climate Controls application.

E. SYSTEM DESCRIPTION

1. The Building Automation System (BAS) shall consist of existing PC-based workstation and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.
2. For this project the system shall consist of the following components:
  - a. Ethernet-based Network Controller(s): The BAS Contractor shall furnish (1 or more) Ethernet-based network controllers as described in Part 2 of the specification. If the existing controller is sufficient to include the new work, a new controller is not required. These controllers shall connect directly to the Operator Workstation over Ethernet, provide communication to the Standalone Digital Control Units and/or other Input/Output Modules and serve as a gateway to equipment furnished by others (if applicable).
  - b. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU shall operate completely standalone, containing all of the I/O and programs to control its associated equipment.
  - c. A high speed Ethernet connection to the school shall be furnished by the school district. BMS contractor shall coordinate with the Owners IT professionals and comply with the Owner's IT professionals requirements.

F. WORK BY OTHERS

1. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

2. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment specified in this section for installation by the Mechanical Contractor.
3. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
  - a. Automatic Control Dampers
  - b. Automatic Control Valves.
  - c. Temperature Sensing Thermal Wells
  - d. Pressure Control Sensing Taps

G. WARRANTY AND ACCEPTANCE

1. The microprocessor temperature control contractor shall warrant the control system installed in this contract to be free from defects in material and workmanship, except for damages from other causes, for a period of one year after final acceptance from the owner. The microprocessor temperature control contractor shall be responsible for all necessary revisions to the software required for a workable system performance through the first year of operation. Any changes in the software shall be transmitted immediately to the owner. The software responsibility is for a complete and workable system as described in the control cycle description of the specification. The software shall become the property of the owner.
2. Updates to the manufacturer's software shall be provided at no charge during the warranty period, unless otherwise purchased by the District under a service agreement.
3. All equipment required to maintain operation of the temperature control system for the project shall be stocked in the microprocessor temperature control contractor's local facility. It shall be immediately available in the event of component failure. A spare or loaner piece of equipment shall be installed immediately when a failure occurs and the equipment shall be returned to the factory for repair.

H. SUBMITTALS

1. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical schematics will be allowed where appropriate.
  - a. Each drawing containing an equipment schematic shall contain a table indicating what equipment is covered by this drawing (i.e. equipment "tag #") and which drawing in the Construction Document set this piece of equipment is shown on.
2. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.
3. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs.
4. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. Prior to submitting, the Contractor shall check all documents for accuracy.
5. The Engineer will make corrections, if required, and return to the Contractor. The Contractor shall then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

6. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS shall be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
  7. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. See Section 3.6 for detail required in Commissioning the system.
  8. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.
- I. OPERATING AND MAINTENANCE MANUALS
1. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead-time and expected frequency of use of each part clearly identified.
  2. Following project completion and testing, the BAS contractor shall submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software in written form.

## **PART 2 - PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer - Provide the following microprocessor control system:
1. Schneider Electric IA Series. All control devices shall be purchased by the Owner and installed by the Temperature Controls Contractor (TCC). The TCC shall be a factory trained and authorized Invensys Climate Control, factory dealer office.
- B. SYSTEM ARCHITECTURE
1. The Building Management System (BMS) shall consist of Network Area Controllers (NACs), a family of Local Controllers, Existing Operator Workstations (OWs), and a File Server to support system configurations where more than three operator workstations are required. The BMS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant SQL database. The system shall be designed with a top-level 10/100bT Ethernet network, using ISO 8802-3 data link/physical layer. A sub-network using the RS-485 token passing protocol, with a minimum of 19.2kb speed, shall connect the local, stand-alone controllers with Ethernet-level controller/routers.
  2. Level 1 Network Description: Level 1, the main backbone of the system, shall be an ISO 8802-3, 10/100bT LAN/WAN, using Ethernet as the communications protocol. Network Area Controllers, Operator Workstations, and Servers shall connect directly to this network without the need for Gateway devices.
  3. Level 2 Network Description: Level 2 of the system shall consist of one or more local Controllers. Minimum speed shall be 19.2kbps. The Level 2 field bus consists of an RS485, BACnet MSTP bus that supports 40-60 Local Controllers to operate HVAC equipment, lighting, power metering and monitoring, fuel tank monitoring, UPS battery and generator monitoring, smoke and fire detection, water leak detection, and video surveillance and access control.

4. BMS LAN Segmentation: The BMS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.
  5. Standard Network Support: All NACs, Workstations and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NACs, Workstations and Servers shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Technology (IT) Department as all devices utilize standard TCP/IP components.
  6. System Expansion: The BMS shall be scalable and expandable at all levels using the same software interface and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
    - a. The BMS shall be expandable to include Video Surveillance and Access Control functions at any time in the future without requiring additional workstations, or Level 1 controllers. Biometric readers, keypads or proximity card access controllers shall be able to be added to the existing Level 1 network, to perform security and access control applications. In this way, an owner's existing investment in wiring infrastructure may be leveraged and the cost and inconvenience of adding new field bus wiring can be minimized.
    - b. Additional web-based operator licenses shall be added in the field through an upgrade of the web server's security key, with no re-programming required.
  7. Support for Open Systems Protocols: The BMS design must include solutions to integrate the following open system protocols: BACnet, Modbus, and digital data communication to third party microprocessors such as chiller controllers, smoke, fire and life safety panels and variable frequency drives (VFDs) – as required to complete the work.
- C. NETWORK CONTROL UNITS (NCUs) – Invensys Climate Control, controllers are basis of design
1. General: Upgrade existing NCU's to the latest version and software revision.
- D. LOCAL CONTROLLERS – Invensys Climate Control, controllers are basis of design.
1. General: Local Controllers shall provide control of HVAC, CRAC units, lighting, power metering, electrical monitoring, UPS, and leak detection. This may include air handling units, rooftop units, variable air volume boxes, unit ventilators, smoke, fire and life safety systems, and other mechanical equipment. Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated NAC.
  2. Hardware Specification:
    - a. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, flash memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
    - b. Communication Ports: Local Controllers shall have a RS-485 communication port field bus, operating at a speed of at least 19.2kbps.
    - c. Input/Output: Each local Controller shall have enough inputs and outputs to meet the application's required point count. Each local controller shall support universal inputs, whereas any input may be software-defined as:
      - 1) Digital Inputs for status/alarm contacts

- 2) Counter Inputs for summing pulses from meters.
  - 3) Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
  - 4) Analog inputs for pressure, humidity, flow and position measurements.
  - d. Local controllers must support both digital and analog output types:
    - 1) Digital Outputs for on/off equipment control.
    - 2) Analog Outputs for valve and damper position control, and capacity control of primary equipment.
  - e. Expandability: For larger controllers (16 base inputs and up), provide input and output expansion through the use of plug-in modules. At least two I/O modules must be capable of being added to the base Local Controller.
  - f. Networking: Each local controller will be able to exchange information on a peer to peer basis with other Interoperable Digital Controller. Each local controller shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each local controller shall be able to have its program viewed and/or enabled/disabled through a workstation connected to an NAC.
  - g. Indicator Lamps: Local Controllers will have as a minimum, LED indication of CPU status, and field bus status.
  - h. Real Time Clock (RTC): All Local Controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each Local Controller shall receive a signal, every hour, over the network from the NAC, which synchronizes all Local Controllers real time clocks.
  - i. Automatic Restart after Power Failure: Upon restoration of power, the Local Controller shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
  - j. Battery Back Up: All Local Controllers shall store all programming in non-volatile flash memory. All Local Controllers except terminal controllers shall include an on-board lithium battery to back up the controller's RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the Local Controller shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the Local Controller shall restart itself from its application program stored in its flash memory.
3. Software Specification:
- a. General: The Local Controller shall contain flash memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each Local Controller shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
  - b. User Programming Language:
    - 1) The application software shall be user programmable. Controllers should be freely programmable. Fixed function controllers will not be accepted.
    - 2) Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Area Controller.

- c. History Logging: Each controller shall be capable of locally logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
  - d. Alarm Management:
    - 1) For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the Local Controllers and can result in the display of one or more alarm messages or reports.
    - 2) Up to 8 alarms can be configured for each point in the controller.
    - 3) Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
    - 4) If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the controller. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.
4. Air Handler Controllers
- a. AHU Controllers shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification and for future expansion.
  - b. AHU Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.
  - c. AHU Controllers shall be fully user programmable to allow for modification of the application software.
5. Unitary Controllers – Invensys Controllers
- a. Unitary Controllers shall support, but not be limited to, control of the following systems as described in the Execution portion of this specification, and for future expansion:
    - 1) Packaged Rooftops
  - b. The I/O of each Unitary Controller shall contain sufficient quantity and types, as required, to meet the sequence of operations found in the Execution portion of this specification. In addition, each controller shall have the capability for local time of day scheduling, occupancy mode control, after hour operation, lighting control, alarming, and trending.
- E. COMMUNICATIONS TO 3RD PARTY DEVICES
- 1. General: Where required, provide a Gateway to interface to that equipment that uses the Modbus protocol, or other proprietary or open protocols.
  - 2. Communication Ports: In addition to its on-board Ethernet port, the Gateway shall have at least two serial communications ports for interfaces to third-party systems.
  - 3. Memory: The Gateway shall have enough RAM memory to store all point configuration data, plus required history logging and alarm buffering. Minimum RAM shall be 8MB. The operating system of the gateway must be stored in flash non-volatile memory.
  - 4. User Programming Language:
    - a. The Gateway shall employ the same user programmable application software that NACs and Local Controllers use.
    - b. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Area Controller. Gateways that do not have an application programming language will not be accepted.

5. History Logging: Each Gateway shall be capable of locally logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
- F. WORKSTATIONS AND SOFTWARE – Upgrade Existing Invensys Climate Control as Required
- G. DDC SENSORS AND POINT HARDWARE
1. General: Where indicated on the drawings, schedules or sequence of operations, provide equipment that conforms to the following specifications:
  2. Temperature Sensors:
    - a. All temperature devices shall use precision thermistors accurate to +/- 0.36°F over a range of -30 to 230°F.
    - b. Standard space sensors shall be provided in an off white enclosure for mounting on a standard electrical box.
    - c. Where manual override of unoccupied mode of control is indicated on the drawings or sequence of operation, provide a push button for selecting after hours operation.
    - d. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified.
    - e. Averaging sensors shall be employed in all mixing plenum applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
    - f. Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
  3. Pressure Sensors:
    - a. Air pressure or differential air pressure measurements in the range of 0 to 10" water column shall be accurate to +/- 1% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Setra model C-264.
    - b. Liquid pressure or differential liquid pressure measurements shall be accurate to +/- 0.25% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-230.
  4. Low Limit Thermostats:
    - a. Safety low limit thermostats shall be vapor pressure type with a 20 foot minimum element. Element shall respond to the lowest temperature sensed by any one foot section. Provide one thermostat for each 25 square foot of coil area.
    - b. Low limit thermostat shall be manual reset and shall be double pole so as to provide input capability for alarm at the BAS.
  5. Current Sensing Status Switches
    - a. Current status switches shall be used to monitor the run status of fans, pumps, motors and electrical loads. Acceptable manufacturer is Veris or approved equal.
  6. Control Valves
    - a. Provide automatic control valves suitable for the specified controlled media (water or glycol). Provide valves that mate and match the material of the connected piping.

- b. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Valves shall be selected to provide an initial pressure drop of not more than 4 psig for water applications. For low pressure steam application, the pressure drop shall be equal to the supply pressure minus the heating element design inlet pressure.
  - c. Normal position of both heating and cooling valves shall be open. Three Way valves shall be piped to fail open to both heating and cooling.
  - d. Electric Bi-Directional actuators are acceptable on VAV Terminal Units and Reheat coil valve control if so noted.
  - e. All electric actuators for applications other than VAV terminal units and Reheat Coil valve Control shall be Proportional analog 4-20Ma or 0-10Vdc input and shall be positioned to reflect the output value of the computer control system and shall be spring return to normal position.
  - f. Belimo or equal
7. Dampers
- a. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers shall be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
  - b. Damper frames shall be hat shaped channel, 4" deep constructed of 16 gauge galvanized steel. Stainless steel side seals, and sintered bronze, oil-impregnated bearings shall also be provided.
  - c. Damper blades shall be 16 gauge galvanized steel and shall be 6" on center. Provide vinyl-grip seals on blades.
  - d. Provide damper linkage that consists of 0.50" diameter steel, cadmium plated and chromate treated pivots. Provide a ¼-20 set-screw with a locking-patch to lock the pivots to a 0.31 diameter aluminum rod. Pivots shall rotate in a Celcon bearing. Blade brackets shall be 12 gauge cadmium plated steel. Blades shall be individually factory adjusted for maximum shut off.
  - e. Provide axles that are steel, 0.350" diameter cadmium plated and driveshafts that are ½" diameter cadmium plated steel, extendable 6".
  - f. For high performance applications, control dampers shall meet or exceed the UL Class I leakage rating.
  - g. Control dampers shall be Ruskin, Arrow or approved equal.
  - h. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control.

### **PART 3 - EXECUTION**

#### **3.01 CONTRACTOR RESPONSIBILITIES**

- A. Demolition: Remove controls which do not remain as part of the building automation system, including all associated abandoned wiring, conduit, and pneumatic tubing within visible area of the new controls, up-to 10 feet away. The Owner will inform the Contractor of any equipment that is to be removed that will remain the property of the Owner. This equipment shall be handled with care so as not to damage it. All other equipment that is removed shall be disposed of by the Contractor.
- B. Cleanup: At the completion of the work, all equipment pertinent to this section shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this section. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

C. Wiring, Conduit and Cable

1. ALL wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes and Division 26 (Electrical Division) specification. Power circuitry shall originate from the nearest available 120V panel.
  - a. All temperature control cable less than 50 volts is to be considered low voltage.
  - b. All low voltage cable is to be run in conduit in any non-accessible concealed space and up to 10 ft. above floor level within mechanical rooms. Wiring above 10 ft or within accessible areas (ceilings, crawl spaces, between furred walls, enclosed chases) may be run exposed with proper support with bridle rings. Wiring is to be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.
  - c. Sensors and wiring on or in concrete or block walls for low voltage cable shall be surface mounted and enclosed in metallic wire-mold.
  - d. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.
  - e. Any cable running in plenum rated areas shall be plenum rated cable.
  - f. Wires and tubing shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.
  - g. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each temperature control panel or controller.
  - h. Metallic surface raceway may be used in finished areas on non accessible masonry walls. All surface raceway in finished areas shall be color matched to the existing finish within the limitations of standard manufacturers' colors.

D. HARDWARE INSTALLATION

1. Installation Practices for Field Devices
  - a. Actuators shall be firmly mounted to give positive movement, and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the actuator stroke.
  - b. Actuators shall be stroked ~5%, tightened and returned to normal position to give a positive seal.
  - c. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
  - d. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
  - e. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
  - f. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. The low pressure port shall be piped to the outside of the building.
2. Enclosures:
  - a. For all I/O requiring field interface devices, these devices where practical shall be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust and moisture, and conceals integral wiring and moving parts.
  - b. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
  - c. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. All locks shall be keyed identically.

d. All outside mounted enclosures shall meet the NEMA-4 rating.

**E. SOFTWARE INSTALLATION**

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

**F. COMMISSIONING AND SYSTEM STARTUP**

1. Point to Point Checkout: Each I/O device (both field mounted and those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
2. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
3. System Acceptance Testing:
  - a. All application software shall be verified and compared against the sequences of operation. Control loops shall be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
  - b. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
  - c. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
  - d. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

**END OF SECTION**

**SECTION 23 2113  
HYDRONIC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Heating water and glycol piping, above grade.
- D. Chilled water piping, above grade.
- E. Equipment drains and overflows.
- F. Pipe hangers and supports.
- G. Unions, flanges, mechanical couplings, and dielectric connections.
- H. Valves:
  - 1. Ball valves.
  - 2. Butterfly valves.
  - 3. Check valves.
- I. Flow controls.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment.
- C. Section 23 0719 - HVAC Piping Insulation.
- D. Section 23 2114 - Hydronic Specialties.
- E. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

**1.03 REFERENCE STANDARDS**

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- D. ASME B31.9 - Building Services Piping 2020.
- E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.
- H. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- I. ASTM B32 - Standard Specification for Solder Metal 2020.
- J. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.
- K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
- L. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications 2018.

- M. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications 2007 (Reapproved 2019).
- N. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.
- O. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2023).
- P. AWWA C606 - Grooved and Shouldered Joints 2022.
- Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Product Data:
  - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
  - 2. Provide manufacturers catalog information.
  - 3. Indicate valve data and ratings.
  - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

**1.05 QUALITY ASSURANCE**

- A. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- B. Coupling Manufacturer:
  - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
  - 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
  - 3. A distributor's representative is not considered qualified to perform the training.
- C. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
  - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

**1.06 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**

**2.01 HYDRONIC SYSTEM REQUIREMENTS**

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
  - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
  - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.

3. Grooved mechanical joints may be used in accessible locations only.
    - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
    - b. Use rigid joints unless otherwise indicated.
    - c. Use gaskets of molded synthetic rubber with central cavity, pressure-responsive configuration, and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
  4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
  1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
  2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
  3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

## **2.02 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE**

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
  1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
  2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
  1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
    - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
    - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
  2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
  3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
    - a. Manufacturers:
      - 1) Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
      - 2) Grinnell Products: [www.grinnell.com/#sle](http://www.grinnell.com/#sle).
      - 3) Viega LLC: [www.viega.us/#sle](http://www.viega.us/#sle).

## **2.03 CHILLED WATER PIPING, ABOVE GRADE**

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
  1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
  2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard drawn; using one of the following joint types:
  1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.

- a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
  - a. Manufacturers:
    - 1) Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
    - 2) Grinnell Products: [www.grinnell.com/#sle](http://www.grinnell.com/#sle).
    - 3) Viega LLC: [www.viega.us/#sle](http://www.viega.us/#sle).

#### **2.04 EQUIPMENT DRAINS AND OVERFLOWS**

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
  1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

#### **2.05 PIPE HANGERS AND SUPPORTS**

- A. Provide hangers and supports that comply with MSS SP-58.
  1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
  2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
  3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
  4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
  5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
  6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
  8. Vertical Support: Steel riser clamp.
  9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.
- C. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
  1. Bases: High-density polypropylene.
  2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
  3. Steel Components: Stainless steel or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
  4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion-resistant material.
  5. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
  6. Manufacturers:
    - a. PHP Systems/Design: [www.phpsd.com/#sle](http://www.phpsd.com/#sle).

#### **2.06 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS**

- A. Unions for Pipe 2 Inches and Less:
  1. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches and Greater:
  1. Ferrous Piping: 150 psig forged steel, slip-on.
  2. Copper Piping: Bronze.

3. Gaskets: 1/16 inch thick, preformed neoprene.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
  1. Dimensions and Testing: In accordance with AWWA C606.
  2. Mechanical Couplings: Comply with ASTM F1476.
  3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
  4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
  5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
  6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
  7. Manufacturers:
    - a. Anvil International: [www.anvilintl.com/#sle](http://www.anvilintl.com/#sle).
    - b. Grinnell Products: [www.grinnell.com/#sle](http://www.grinnell.com/#sle).
    - c. Victaulic Company: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- D. Dielectric Connections:
  1. Waterways:
    - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
    - b. Dry insulation barrier able to withstand 600-volt breakdown test.
    - c. Construct of galvanized steel with threaded end connections to match connecting piping.
    - d. Suitable for the required operating pressures and temperatures.
  2. Flanges:
    - a. Dielectric flanges with same pressure ratings as standard flanges.
    - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
    - c. Dry insulation barrier able to withstand 600-volt breakdown test.
    - d. Construct of galvanized steel with threaded end connections to match connecting piping.
    - e. Suitable for the required operating pressures and temperatures.

## 2.07 BALL VALVES

- A. Manufacturers:
  1. Anvil International: [www.anvilintl.com/#sle](http://www.anvilintl.com/#sle).
  2. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
  3. Victaulic Company: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- B. Up To and Including 2 Inches:
  1. Bronze one piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
- C. Over 2 Inches:
  1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle or gear operated, flanged ends, rated to 800 psi.

## 2.08 BUTTERFLY VALVES

- A. Manufacturers:
  1. Anvil International: [www.anvilintl.com/#sle](http://www.anvilintl.com/#sle).
  2. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
  3. Victaulic Company: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.

- C. Disc: Construct of chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- D. Stem: Stainless steel with stem offset from the centerline to provide full 360-degree circumferential setting.
- E. Operator: 10 position lever handle.

## **2.09 SWING CHECK VALVES**

- A. Manufacturers:
  - 1. Anvil International: [www.anvilintl.com/#sle](http://www.anvilintl.com/#sle).
  - 2. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
  - 3. Victaulic Company: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- B. Up To and Including 2 Inches:
  - 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.
- C. Over 2 Inches:
  - 1. Iron body, bronze trim, stainless steel or bronze swing disc, renewable disc and seat, flanged or grooved ends.

## **2.10 SPRING LOADED CHECK VALVES**

- A. Manufacturers:
  - 1. Anvil International: [www.anvilintl.com/#sle](http://www.anvilintl.com/#sle).
  - 2. Shurjoint Piping Products, Inc: [www.shurjoint.com/#sle](http://www.shurjoint.com/#sle).
  - 3. Victaulic Company: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

## **2.11 FLOW CONTROLS**

- A. Manufacturers:
  - 1. Griswold Controls: [www.griswoldcontrols.com/#sle](http://www.griswoldcontrols.com/#sle).
  - 2. Hays Fluid Controls: [www.haysfluidcontrols.com/#sle](http://www.haysfluidcontrols.com/#sle).
  - 3. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
  - 4. Victaulic Company: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, glycol, chilled water piping to ASME B31.9 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

- D. Install piping to conserve building space and to avoid interference with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors.
- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- H. Slope piping and arrange to drain at low points.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.
- J. Grooved Joints:
  - 1. Install in accordance with the manufacturer's latest published installation instructions.
  - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- K. Inserts:
  - 1. Provide inserts for placement in concrete formwork.
  - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- L. Pipe Hangers and Supports:
  - 1. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
  - 2. Place hangers within 12 inches of each horizontal elbow.
  - 3. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - 6. Provide copper plated hangers and supports for copper piping.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.
- N. Install valves with stems upright or horizontal, not inverted.

### **3.03 SCHEDULES**

- A. Hanger Spacing for Copper Tubing.
  - 1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
  - 2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
  - 3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  - 4. 2-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Piping.
  - 1. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  - 2. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  - 3. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
  - 4. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
  - 5. 8 Inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
  - 6. 10 Inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.

**END OF SECTION**

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**SECTION 23 2114  
HYDRONIC SPECIALTIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Suction diffusers.
- F. Pump connectors.
- G. Combination pump discharge valves.
- H. Pressure-temperature test plugs.
- I. Balancing valves.
- J. Combination flow controls.
- K. Relief valves.
- L. Pressure reducing valves.
- M. Glycol system.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

**1.03 REFERENCE STANDARDS**

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2023.

**PART 2 PRODUCTS**

**2.01 EXPANSION TANKS**

- A. Manufacturers:
  - 1. Amtrol Inc: [www.amtrol.com/#sle](http://www.amtrol.com/#sle).
  - 2. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
  - 3. Taco, Inc: [www.taco-hvac.com/#sle](http://www.taco-hvac.com/#sle).
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi.
- D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

**2.02 AIR VENTS**

- A. Manufacturers:
  - 1. Armstrong International, Inc: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
  - 2. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
  - 3. Taco, Inc: [www.taco-hvac.com/#sle](http://www.taco-hvac.com/#sle).
- B. Manual Type: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

- C. Float Type:
  1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
  2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

### 2.03 AIR SEPARATORS

- A. Coalescing Air/Dirt Separators:
  1. Manufacturers:
    - a. Armstrong International, Inc: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
    - b. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
    - c. Spirotherm, Inc: [www.spirotherm.com/#sle](http://www.spirotherm.com/#sle).
  2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1; for 150 psi operating pressure and 270 degrees F maximum operating temperature; subject to the requirements of the application and the manufacturer's standard maximum operating conditions.
  3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
  4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to the top of the separator.
  5. Inlet and Outlet Connections: Threaded for 2 NPS and smaller; Class 150 flanged connections for 2-1/2 NPS and larger.
  6. Blowdown Connection: Threaded.
  7. Size: Match system flow capacity.

### 2.04 STRAINERS

- A. Manufacturers:
  1. Armstrong International, Inc: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
  2. Grinnell Products: [www.grinnell.com/#sle](http://www.grinnell.com/#sle).
  3. The Metraflex Company: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
- B. Size 2 inch and Under:
  1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
  1. Provide flanged or grooved iron body for 175 psi working pressure, Y pattern with 1/16 inch or 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
  1. Provide flanged or grooved iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

### 2.05 SUCTION DIFFUSERS

- A. Manufacturers:
  1. Anvil International: [www.anvilintl.com/#sle](http://www.anvilintl.com/#sle).
  2. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
  3. Victaulic Company of America: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

## **2.06 PUMP CONNECTORS**

- A. Manufacturers:
  - 1. The Metraflex Company: [www.metraflex.com/#sle](http://www.metraflex.com/#sle).
- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
  - 1. Maximum Allowable Working Pressure: 150 psig at 200 degrees F.
  - 2. Accommodate the Following:
    - a. Axial Deflection in Compression and Expansion: 1 inch.
    - b. Lateral Movement: 1 inch.
    - c. Angular Rotation: 15 degrees.
    - d. Force developed by 1.5 times specified maximum allowable operating pressure.
  - 3. End Connections: Same as specified for pipe jointing.

## **2.07 COMBINATION PUMP DISCHARGE VALVES**

- A. Manufacturers:
  - 1. Anvil International: [www.anvilintl.com/#sle](http://www.anvilintl.com/#sle).
  - 2. Taco, Inc: [www.taco-hvac.com/#sle](http://www.taco-hvac.com/#sle).
  - 3. Victaulic Company of America: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

## **2.08 PRESSURE-TEMPERATURE TEST PLUGS**

- A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- B. Application: Use extended length plugs to clear insulated piping.

## **2.09 BALANCING VALVES**

- A. Manufacturers:
  - 1. Armstrong International, Inc: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
  - 2. Hays Fluid Controls: [www.haysfluidcontrols.com/#sle](http://www.haysfluidcontrols.com/#sle).
  - 3. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
- B. Size 2 inch and Smaller:
  - 1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or grooved connections.
  - 2. Metal construction materials consist of bronze or brass.
  - 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- C. Size 2.5 inch and Larger:
  - 1. Provide globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
  - 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
  - 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

## **2.10 COMBINATION FLOW CONTROLS**

- A. Manufacturers:
  - 1. Armstrong International: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
  - 2. Hays Fluid Controls: [www.haysfluidcontrols.com/#sle](http://www.haysfluidcontrols.com/#sle).
  - 3. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).

- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
- D. Provide with inlet and outlet unions as required.
- E. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

## **2.11 RELIEF VALVES**

- A. Manufacturers:
  - 1. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
  - 2. Armstrong International, Inc: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
  - 3. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

## **2.12 PRESSURE REDUCING VALVES**

- A. Manufacturers:
  - 1. Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
  - 2. Armstrong International, Inc: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
  - 3. ITT Bell & Gossett: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 2113.
- C. Materials of Construction:
  - 1. Valve Body: Constructed of bronze or brass.
  - 2. Internal Components: Construct of stainless steel or brass and engineered plastics or composition material.
- D. Connections:
  - 1. Soldered: 0.50 inch.
- E. Provide integral check valve and strainer.
- F. Maximum Fluid Temperature: 180 degrees F.

## **2.13 GLYCOL SYSTEM**

- A. Fully automated and autonomous. Complete with 110V (77 Watts) pressurization pump with intergal pressure control, pressure reducing valave guage, and 18 gallon translucent polyethylene solution container with lid designed to accommodate relief piping.
- B. Design Make: Wessels Company Model GMP-18.
- C. Glycol Solution:
  - 1. Inhibited propylene glycol and water solution mixed 40 percent glycol - 60 percent water, suitable for operating temperatures from minus 40 degrees F to 250 degrees F.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide valved drain and hose connection on strainer blowdown connection.
- G. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- I. Support pump fittings with floor-mounted pipe and flange supports.
- J. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- L. Clean and flush glycol system before adding glycol solution. Refer to Section 23 2500.
- M. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- N. Perform tests determining strength of glycol and water solution and submit written test results.

**END OF SECTION**

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**SECTION 23 2213  
STEAM AND CONDENSATE HEATING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Pipe and pipe fittings.
- B. Pipe hangers and supports.
- C. Steam piping system.
- D. Steam condensate piping system.

**1.02 RELATED REQUIREMENTS**

- A. Section 09 9123 - Interior Painting.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment.
- C. Section 23 0719 - HVAC Piping Insulation.
- D. Section 23 2214 - Steam and Condensate Heating Specialties.
- E. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

**1.03 REFERENCE STANDARDS**

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
- B. ASME B31.1 - Power Piping 2022.
- C. ASME B31.9 - Building Services Piping 2020.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.
- F. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2023).
- G. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

**1.04 SYSTEM DESCRIPTION**

- A. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- B. Use unions and flanges downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.
- C. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- D. Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

**1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.

- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

#### **1.06 QUALITY ASSURANCE**

- A. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labelling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

### **PART 2 PRODUCTS**

#### **2.01 REGULATORY REQUIREMENTS**

- A. Comply with ASME B31.9 and ASME B31.1 code for installation of piping system.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

#### **2.02 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)**

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
  - 1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A234/A234M wrought steel.
  - 2. Joints: Threaded, or AWS D1.1/D1.1M welded.

#### **2.03 LOW PRESSURE STEAM CONDENSATE PIPING**

- A. Steel Pipe: ASTM A53/A53M, Schedule 80, black.
  - 1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A234/A234M wrought steel.
  - 2. Joints: Threaded, or AWS D1.1/D1.1M welded.

#### **2.04 PIPE HANGERS AND SUPPORTS**

- A. Provide hangers and supports that comply with MSS SP-58.
  - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Hangers for Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- C. Hangers for Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
- D. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches: Steel channels with welded spacers and hanger rods.
- E. Multiple or Trapeze Hangers for Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.
- F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- G. Wall Support for Pipe Sizes 4 to 5 Inches: Welded steel bracket and wrought steel clamp.
- H. Wall Support for Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
- I. Vertical Support: Steel riser clamp.
- J. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- K. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## **2.05 UNIONS, FLANGES, AND COUPLINGS**

- A. Unions for Pipe 2 Inches and Under:
  - 1. Ferrous Piping: 150 psig galvanized malleable iron, threaded.
- B. Flanges for Pipe Over 2 Inches:
  - 1. Ferrous Piping: 150 psig forged steel, slip-on.
  - 2. Gaskets: 1/16 inch thick preformed non-asbestos graphite fiber.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. See Section 23 2500.

### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Sleeve pipe passing through partitions, walls, and floors.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Pipe Hangers and Supports:
  - 1. Install in accordance with ASME B31.9.
  - 2. Support horizontal piping as indicated.
  - 3. Place hangers within 12 inches of each horizontal elbow.
  - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - 6. Prime coat exposed steel hangers and supports. See Section 09 9123 Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Slope steam piping one inch in 40 feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.
- I. Slope steam condensate piping one inch in 40 feet. Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- K. Install valves with stems upright or horizontal, not inverted.

### **3.03 SCHEDULES**

- A. Hanger Spacing for Steel Steam Piping.
  - 1. 3/4 inch and 1 inch: Maximum span, 9 feet; minimum rod size, 1/4 inch.

2. 1-1/4 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 13 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 14 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 15 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.

B. Hanger Spacing for Steel Steam Condensate Piping.

1. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
2. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
3. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
4. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
5. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.

**END OF SECTION**

**SECTION 23 2214  
STEAM AND CONDENSATE HEATING SPECIALTIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Steam traps.
- B. Steam air vents.
- C. Safety relief valves.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 0719 - HVAC Piping Insulation.
- B. Section 23 2213 - Steam and Condensate Heating Piping.

**1.03 REFERENCE STANDARDS**

- A. ASME B31.9 - Building Services Piping 2020.
- B. ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications 2023.
- C. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2022).

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data:
  - 1. Provide for manufactured products and assemblies required for this project.
  - 2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
  - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
  - 4. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate application, selection, and hookup configuration. Include pipe and accessory elevations.
- D. Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

**PART 2 PRODUCTS**

**2.01 STEAM TRAPS**

- A. Manufacturers:
  - 1. Armstrong International, Inc: [www.armstronginternational.com/#sle](http://www.armstronginternational.com/#sle).
  - 2. Marshall Engineered Products Company: [www.mepcollc.com/#sle](http://www.mepcollc.com/#sle).
  - 3. Spirax-Sarco: [www.spiraxsarco.com/us/#sle](http://www.spiraxsarco.com/us/#sle).
- B. Steam Trap Applications:
  - 1. Use Thermostatic Steam Traps for:

- a. Steam radiation units.
- b. Convectors.
- c. Unit ventilators.
- d. Other similar terminal heating units.
- 2. Use Float and Thermostatic Traps for:
  - a. Unit heaters.
  - b. Converters.
  - c. Heating coils.
  - d. Main headers.
  - e. Branch lines.
- C. Steam Trap Performance:
  - 1. Select to handle minimum of two times maximum condensate load of apparatus served.
  - 2. Pressure Differentials:
    - a. Low Pressure Systems (15 psi maximum): 2 psi.
- D. Float and Thermostatic Steam Traps:
  - 1. Metal body with bolted cover, stainless steel or bronze bellows type thermostatic air vent, stainless steel or copper float, stainless steel lever valve assembly, bottom drain plug, and accessible to internal parts without disturbing piping.
  - 2. H-Pattern, Series Connected:
    - a. Cast iron body, stainless steel internals with hardened seat, and threaded pipe-end connections for pressures up to 75 psi and temperatures up to 450 degrees F.
  - 3. In-line, Series Connected:
    - a. Repairable stainless steel body, stainless steel internals with hardened seat, and threaded pipe-end connections for pressures up to 225 psi and temperatures up to 450 degrees F.
  - 4. Parallel Connected:
    - a. Cast iron body, stainless steel internals with hardened seat, and threaded pipe-end connections for pressures up to 250 psi and temperatures up to 450 degrees F.
- E. Pressure Balanced Thermostatic Traps: ASTM A395/A395M cast iron body and bolted or screwed cover, and integral ball joint union for 125 psi WSP; phosphor bronze bellows, stainless steel valve and seat, integral stainless steel strainer.
- F. Freezeproof Thermostatic Traps: Cast iron body for 300 psi WSP, bronze bellows, stainless steel valve and seat, external adjustment.
- G. Bi-metallic Thermostatic Steam Traps:
  - 1. ASTM A105/A105M forged steel body, integral stainless steel strainer, freeze proof, water hammer resistant, and flanged pipe-end connections for differential pressures up to 300 psi. Fabricated to allow in-line service.

## **2.02 STEAM AIR VENTS**

- A. 125 psi WSP: Balanced pressure type; cast brass body and cover; access to internal parts without disturbing piping; stainless steel bellows, stainless steel valve and seat.

## **2.03 SAFETY RELIEF VALVES**

- A. Valve: Bronze body, stainless steel valve spring, stem, and trim, direct pressure actuated, capacities ASME certified and labelled.
- B. Accessories: Drip pan elbow.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install steam and steam condensate piping and specialties in accordance with ASME B31.9.

- B. Install specialties in accordance with manufacturer's instructions.
- C. Steam Traps:
  - 1. Provide minimum 3/4 inch size on steam mains and branches.
  - 2. Install with union or flanged connections at both ends.
  - 3. Provide gate valve and strainer at inlet, and gate valve and check valve at discharge.
  - 4. Provide minimum 10 inch long, line size dirt pocket between apparatus and trap.
- D. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

**END OF SECTION**

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**SECTION 23 3100  
HVAC DUCTS AND CASINGS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Metal ductwork.
- B. Nonmetal ductwork.
- C. Kitchen hood ductwork.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- B. Section 23 0713 - Duct Insulation: External insulation and duct liner.
- C. Section 23 3300 - Air Duct Accessories.
- D. Section 23 3700 - Air Outlets and Inlets.

**1.03 REFERENCE STANDARDS**

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2023.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2023.
- D. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- E. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023b.
- G. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements 2018, with Editorial Revision (2020).
- H. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements 2017, with Editorial Revision (2020).
- I. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2024.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- K. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines 2001.
- L. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual 2012.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings:
  - 1. Prepare 1/4 inch scale or larger drawings within 30 days after contract award for all areas.
    - a. Incorporate dimensions of actual equipment used. (Including light fixtures, structural steel etc.)
    - b. Show adequate sections, elevations and plan views.
    - c. Indicate all dampers and other required accessories.
    - d. indicate size, type, and location of all access doors.
    - e. Include size and location of all floor, wall and roof openings.

- f. Indicate elevation above floor and ceiling height for each room.
- g. Indicate SMACNA pressure class required for all duct.
- 2. Identify in writing, any deviations from contract Drawings and Specifications.
  - a. Highlight all changes from plans required by obstructions and job conditions.
  - b. If shop standards do not conform in detail to specifications, submit for approval annotated shop standards showing upgrades as required for conformance.
  - c. Call to Architect's attention, in writing by separate letter along with samples for clarification, any proposed deviations from contract plans and specifications.

### **1.05 FIELD CONDITIONS**

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

## **PART 2 PRODUCTS**

### **2.01 DUCT ASSEMBLIES**

- A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (Heating Systems): 2 inch w.g. pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 2 inch w.g. pressure class, galvanized steel.
- E. Return and Relief: 1 inch w.g. pressure class, galvanized steel.
- F. General Exhaust: 1 inch w.g. pressure class, galvanized steel.
- G. Locker Room and Shower Room Exhaust: 1 inch w.g. pressure class, aluminum.
- H. Kitchen Cooking Hood Exhaust: 1 inch w.g. pressure class, stainless steel.
  - 1. Construct of 16 gage, 0.0598 inch sheet steel using continuous external welded joints in rectangular sections.
- I. Dishwasher Exhaust: 1 inch w.g. pressure class, stainless steel.
  - 1. Construct of 16 gage, 0.0598 inch sheet steel using continuous external welded joints in rectangular sections.
- J. Grease Exhaust: 1 inch w.g. pressure class, stainless steel.
  - 1. Construct of 18 gage, 0.0500 inch stainless steel.
  - 2. Construction:
    - a. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
  - 3. Access Doors:
    - a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
    - b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.
- K. Outside Air Intake: 1 inch w.g. pressure class, galvanized steel.
- L. Combustion Air: 1 inch w.g. pressure class, galvanized steel.
- M. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, sound lined galvanized steel..

### **2.02 MATERIALS**

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
- C. Stainless Steel for Ducts: ASTM A666, Type 304.

- 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: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
  - 3. For Use With Flexible Ducts: UL labeled.
- E. Gasket Tape: Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle rings connections.
- F. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- G. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
  - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
  - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.

### **2.03 DUCTWORK FABRICATION**

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

### **2.04 MANUFACTURED DUCTWORK AND FITTINGS**

- A. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
  - 1. Manufacture in accordance with SMACNA (DCS).
- B. Round Ducts: Round lockseam duct with galvanized steel outer wall.
  - 1. Manufacture in accordance with SMACNA (DCS).
- C. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
  - 1. UL labeled.
  - 2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
  - 3. Pressure Rating: 4 inches WG positive and 0.5 inches WG negative.
  - 4. Maximum Velocity: 4000 fpm.
  - 5. Temperature Range: Minus 20 degrees F to 175 degrees F.
- D. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
- E. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
- F. Kitchen Cooking Hood and Grease Exhaust: Nominal 3 inches thick ceramic fiber insulation between 20 gage, 0.0375 inch, Type 304 stainless steel liner and 24 gage, 0.0239 inch aluminized steel sheet outer jacket.

1. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
  2. Certified for zero clearance to combustible material in accordance with:
  3. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:
- G. Dishwasher Exhaust: Minimum 21 gage, 0.0344 inch thick, single wall, Type 304 stainless steel.
1. Single wall, factory built chimney liner system.
  2. Joints to be sealed during installation with factory supplied overlapping V-bands and sealant.

## **2.05 KITCHEN HOOD EXHAUST DUCTWORK**

- A. Fabricate in accordance with ductwork manufacturer's installation instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- D. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. Connect diffusers to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- G. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

**END OF SECTION**

**SECTION 23 3300  
AIR DUCT ACCESSORIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 23 3100 - HVAC Ducts and Casings.

**1.03 REFERENCE STANDARDS**

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.
- B. NFPA 92 - Standard for Smoke Control Systems 2021, with Amendment.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2024.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service Current Edition, Including All Revisions.
- F. UL 555 - Standard for Fire Dampers Current Edition, Including All Revisions.
- G. UL 555S - Standard for Smoke Dampers Current Edition, Including All Revisions.
- H. UL 1978 - Grease Ducts Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.

**1.05 QUALITY ASSURANCE**

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

**1.06 DELIVERY, STORAGE, AND HANDLING**

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

**PART 2 PRODUCTS**

**2.01 AIR TURNING DEVICES/EXTRACTORS**

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

**2.02 BACKDRAFT DAMPERS - METAL**

- A. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

### 2.03 DUCT ACCESS DOORS

- A. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
  - 1. Less Than 12 inches Square: Secure with sash locks.
  - 2. Up to 18 inches Square: Provide two hinges and two sash locks.
  - 3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
  - 4. High Temperature Duct Access Doors:
    - a. Comply with NFPA 96.
    - b. Comply with UL 1978.
- B. Access doors with sheet metal screw fasteners are not acceptable.

### 2.04 FIRE DAMPERS

- A. Manufacturers:
  - 1. Louvers & Dampers, Inc, a brand of Mestek, Inc: [www.louvers-dampers.com/#sle](http://www.louvers-dampers.com/#sle).
  - 2. Nailor Industries, Inc: [www.nailor.com/#sle](http://www.nailor.com/#sle).
  - 3. Ruskin Company: [www.ruskin.com/#sle](http://www.ruskin.com/#sle).
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Horizontal Dampers: Galvanized steel, 22 gage, 0.0299 inch frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.
- E. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

### 2.05 FLEXIBLE DUCT CONNECTORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
  - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.

### 2.06 SMOKE DAMPERS

- A. Manufacturers:
  - 1. Louvers & Dampers, Inc, a brand of Mestek, Inc: [www.louvers-dampers.com/#sle](http://www.louvers-dampers.com/#sle).
  - 2. Nailor Industries, Inc: [www.nailor.com/#sle](http://www.nailor.com/#sle).
  - 3. Ruskin Company: [www.ruskin.com/#sle](http://www.ruskin.com/#sle).
- B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- C. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by electric actuator.

### 2.07 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Splitter Dampers:
  - 1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
  - 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.

3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .
- C. Single Blade Dampers:
  1. Fabricate for duct sizes up to 6 by 30 inch.
  2. Blade: 24 gage, 0.0239 inch, minimum.
- D. Multi-Blade Damper: Fabricate of 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 gage, 0.0478 inch, minimum.
- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide combination fire and smoke dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- H. Use splitter dampers only where indicated.

**END OF SECTION**

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**SECTION 23 3423  
HVAC POWER VENTILATORS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Roof exhausters.
- B. Cabinet exhaust fans.
- C. Inline centrifugal fans.
- D. Laboratory and fume exhaust.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 3300 - Air Duct Accessories: Backdraft dampers.

**1.03 REFERENCE STANDARDS**

- A. AMCA 99 - Standards Handbook 2016.
- B. ANSI Z9.5 - Laboratory Ventilation 2022.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- D. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2024.
- E. UL 705 - Power Ventilators Current Edition, Including All Revisions.
- F. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

**1.05 FIELD CONDITIONS**

- A. Permanent ventilators may not be used for ventilation during construction.

**PART 2 PRODUCTS**

**2.01 POWER VENTILATORS - GENERAL**

- A. Manufacturers:
  - 1. Greenheck Fan Corporation: [www.greenheck.com/#sle](http://www.greenheck.com/#sle).
  - 2. PennBarry, Division of Air System Components: [www.pennbarry.com/#sle](http://www.pennbarry.com/#sle).
- B. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- C. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- D. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
- E. Fabrication: Comply with AMCA 99.
- F. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- G. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

- H. Enclosed Safety Switches: Comply with NEMA 250.
- I. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

## **2.02 ROOF EXHAUSTERS**

- A. Manufacturers:
  - 1. Greenheck Fan Corporation: [www.greenheck.com/#sle](http://www.greenheck.com/#sle).
  - 2. PennBarry, Division of Air System Components: [www.pennbarry.com/#sle](http://www.pennbarry.com/#sle).
- B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- C. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

## **2.03 CABINET EXHAUST FANS**

- A. Manufacturers:
  - 1. Greenheck Fan Corporation: [www.greenheck.com/#sle](http://www.greenheck.com/#sle).
  - 2. PennBarry, Division of Air System Components: [www.pennbarry.com/#sle](http://www.pennbarry.com/#sle).
- B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
- C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

## **2.04 INLINE CENTRIFUGAL FANS**

- A. Manufacturers:
  - 1. Greenheck Fan Corporation: [www.greenheck.com/#sle](http://www.greenheck.com/#sle).
  - 2. Loren Cook Company: [www.lorencook.com/#sle](http://www.lorencook.com/#sle).
  - 3. PennBarry, Division of Air System Components: [www.pennbarry.com/#sle](http://www.pennbarry.com/#sle).
- B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
- C. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with stainless steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- D. Hung Cabinet Fans:
  - 1. Install fans with resilient mountings and flexible electrical leads.

2. Install flexible connections specified in Section 23 3300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

**END OF SECTION**

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**SECTION 23 3513  
DUST COLLECTION SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Ductwork and duct fittings.
- B. Inlet fittings.
- C. Outdoor Wood Dust Collector.
- D. Accessories.

**1.02 REFERENCE STANDARDS**

- A. ACGIH (IV) - Industrial Ventilation: A Manual of Recommended Practice for Design, 30th Edition 2019, with Errata (2021).
- B. SMACNA (ROUND) - Round Industrial Duct Construction Standards 2013.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate dimensions, sizes, weights and point loadings, material thickness, and locations and sizes of field connections. Submit construction layout and details for inlet fittings.
- C. Product Data: Provide manufacturers literature and data indicating rated capacities, dimensions, weights and point loadings, accessories, electrical characteristics and connection requirements, wiring diagrams, and location and sizes of field connections.
- D. Manufacturer's Installation Instructions: Indicate assembly and installation instructions.
- E. Operation and Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

**PART 2 PRODUCTS**

**2.01 DUCTWORK AND DUCT ACCESSORIES**

- A. Manufacturers:
  - 1. Ceco KB Duct: [www.cecoenviro.com/#](http://www.cecoenviro.com/#).
  - 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Product Description:
  - 1. The system is a full line of duct and components. All parts are of standard sheet metal construction with a rolled lip applied to each end of the component. An all stainless over-center locking clamp is used to encompass the rolled lips, pull them together and then security join them. Adapters enable connection to virtually any machine.
- C. Clamp;
  - 1. The clamp is fitted with a "winged a-ring" gasket made of N-Butyl Rubber. The gasket is designed to fully encompass the entirety of the rolled lips including the area formed by the "V" between the rolled lips.
- D. Duct and Adustability:
  - 1. The duct is a nominal 5' length. Adjustable sleeves and adjustable components enable the installer to quickly make odd lengths and to adjust for a proper fit. To utilize this feature, a cut piece of pipe is slid into the sleeve or fitting and secured with an a-ring and standard clamp.
- E. Product Materials:

1. Material duct and components are to be galvanized/galvannealed for field painting. Standard gauges for the duct are 26 ga for 3", 24 ga for 4-6", 22 ga for 7-9". Elbows are typically one gauge heavier than standard duct gauge. All components (branches, reducers etc) are of 18 ga material.

## 2.02 OUTDOOR WOOD DUST COLLECTOR

- A. Manufacturers:
  1. Sternvent; Vibraclean Model DKPD 36007-2-2RI: [www.sternvent.com](http://www.sternvent.com).
  2. American Air Filter Arrestall: [www.aaf-ae.com](http://www.aaf-ae.com).
  3. Donaldson Unimaster: [www.donaldson.com](http://www.donaldson.com).
- B. Furnish and install, where shown on the plans, a high efficiency filter type dust collector with integral blower sized for design air flow of 3,000 CFM @ 9.0" WG Ext. SP.
- C. Dust collector shall be self-cleaning fabric type complete with cotton filters, backward inclined blower, motorized shaker, factory wired controller and external discharge silencer. Manufacturer's literature shall state that dust collector and selected filter spacing is designed for the collection of wood dust.
- D. Dust collector shall be airtight, all steel construction with sealed seams and gasketed quick opening doors with 1/4 turn knobs. Housing shall be a minimum of 14-ga. mild steel. Unit shall consist of a filter section, with sloped roof to shed rain and a funnel bottom section without slide gates or doors to allow downflow of dust directly into two 55-gallon drum assembly furnished by manufacturer. Inlet, with baffle, shall be centered on side for even distribution of dust to the drum. Designs with inlet on narrow side shall not be accepted. Include an explosion relief vent, in the dirty section of the filter housing, per NFPA #664.
- E. Unit to include a multi-pocket filter modules, which is sewn from 8-ounce cotton sateen fabric designed to deliver in excess of 99.5% efficiency by weight on industrial dusts. The filters shall have closed bottom and open top pockets, for the wood waste to remain on the outside surfaces of the filter media. Inside of each pocket shall be a rigid insert separator to prevent collapse of filters and loss of the effective filter area. Flat shaker fingers located at the bottom of the filter module shall prevent adjoining pockets from touching one another and blanking off. The filter pocket spacing shall be wide spacing to permit the collected dust to be shaken off the exterior of the filters and recommended by the manufacturer for the collection of wood dust. Total airflow to filter fabric area (air to cloth ratio) shall not exceed 10 CFM per square foot.
  1. Filter designs with open bottoms that allow the wood waste to enter the inside of the filters will not be accepted, because of the potential for wood waste to bridge and not shake down.
  2. Each filter module shall be secured in place by two lever, operated over-center, locking mechanisms to assure a positive seal and allow for easy removal of filters from outside of unit. Designs which require entry into unit (confined space) or require hand tools to remove the filters, for filter maintenance, are not acceptable.
- F. Filters will be cleaned automatically after a fifteen second delay following the shutdown of the blower, by the oscillating action delivered by the motorized eccentric driven shaker assembly, which imparts a rapid and strong vibratory force throughout the entire surface of each individual filter pocket to dislodge the dust. Filters that are suspended from bungee cords or rubber bands are not acceptable. Shaker motor shall be 1/3hp.
  1. Operation of the automatic shaker shall be controlled by a solid state, dual mode timer with adjustable shaker cycle range from 1.8 - 180 seconds, VFD for blower motor, magnetic starter with overload relay for shaker motor and transformer in a NEMA12 control panel for indoor mounting. Outdoor NEMA 3R safety disconnect switch shipped loose for field mounting & wiring by electrical contractor. Also included shall be a push button station for remote mounting.

- G. The control panel wiring shall be either UL or ETL labeled for compliance with 508A. Control panels not labeled by dust collector manufacturer shall be labeled, in field, by a certified UL or ETL representative, prior to placing equipment in operation.
- H. The integral non-sparking AMCA Type C direct drive blower shall be located on the clean air side of the filters, top mounted at the factory and be of the backward inclined design with a dynamically balanced impeller. It shall be driven by a 7.5HP 3450 RPM, TEFC motor. The blower shall be tested in accordance with AMCA Standard 210. A factory-supplied cover shall protect the motor cooling fan from ice.
- I. Discharge noise from the blower shall be attenuated by an external field supported duct silencer fabricated with 4.75 lb. density inorganic mineral or glass fiber. This media shall be protected from erosion by the air flow through the use of galvanized perforated metal with aerodynamic leading and trailing edges to insure maximum acoustical insertion loss at minimum static pressure drop. Lining of the fan scroll, instead of an external silencer, shall not be accepted. Include factory installed bird screen on discharge of silencer.
- J. Interior and exterior carbon steel surfaces shall be coated with two part epoxy primer and exterior painted with gray two part urethane enamel.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install equipment in accordance with manufacturer's instructions.
- B. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

**END OF SECTION**

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**SECTION 23 3700  
AIR OUTLETS AND INLETS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Diffusers:
  - 1. Rectangular ceiling diffusers.
  - 2. Round ceiling diffusers.
  - 3. Slot ceiling diffusers.
- B. Registers/grilles:
  - 1. Ceiling-mounted, egg crate exhaust and return register/grilles.
  - 2. Ceiling-mounted, exhaust and return register/grilles.
  - 3. Ceiling-mounted, supply register/grilles.
- C. Duct-mounted supply and return registers/louvers.
- D. Louvers:
- E. Roof hoods.

**1.02 REFERENCE STANDARDS**

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.
- B. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Krueger-HVAC: [www.krueger-hvac.com/#sle](http://www.krueger-hvac.com/#sle).
- B. Price Industries: [www.price-hvac.com/#sle](http://www.price-hvac.com/#sle).
- C. Ruskin Company: [www.ruskin.com/#sle](http://www.ruskin.com/#sle).
- D. Titus, a brand of Air Distribution Technologies: [www.titus-hvac.com/#sle](http://www.titus-hvac.com/#sle).

**2.02 SUPPLY AIR OUTLETS**

- A. Type 'S1':
  - 1. Model: Titus OMNI-AA.
  - 2. Description: Aluminum - Square ceiling diffuser with round neck and plaque face. Back cone shall be one piece seamless construction and incorporate a round inlet collar of sufficient length for connecting, rigid or flexible duct.
  - 3. Diffuser shall integrate with all duct sizes shown on plans without affecting face size or appearance.
  - 4. Provide factory insulated R-6 foil backed insulation on outside of back cone.
  - 5. Border: Provide appropriate border to accommodate mounting per ceiling type.
  - 6. Ensure optimal performance to 30% of design air flow in VAV Systems.
  - 7. Finish: #26 White.
- B. Type 'S2'
  - 1. Model: Titus R-OMNI
  - 2. Description: Steel - Adjustable round ceiling diffuser.

3. Uniform 360 degree discharge pattern. The discharge pattern can be adjusted in 3 fixed plaque positions from horizontal to vertical throw.
  4. Border: Heavy gauge steel construction.
  5. Finish: #26 White.
- C. Type 'S3':
1. Model: Titus CT-541.
  2. Description: Aluminum - Linear bar grille with 15 degree blades spaced at 1/2" on center. Outlet core shall have extruded aluminum receiving bar. Blades shall run parallel to long dimension of grille. The support and receiving bars shall not exceed 8" on center.
  3. Border: Grille border shall be heavy duty extruded aluminum construction with precise mitered corners and reinforcing support bars for extra support for the core receiving bar.
  4. Grille Finish: #26 White.

### 2.03 RETURN AIR INLETS

- A. Type 'R1':
1. Model: Titus 50 F.
  2. Description: Aluminum 1/2"x1/2"x1" grids (egg crate core) with extruded aluminum border. Sized per schedule on drawings.
  3. Border: Type 3 for lay-in installation, Type 1 for surface mount. Panel mounting shall not be allowed.
  4. Provide with factory fabricated square to round adapter for connection to ductwork.
  5. Finish: #26 White.
- B. Type 'R2':
1. Model: Titus 350 RL.
  2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
  3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Surface mount to side wall.
  4. Finish: #26 White.

### 2.04 EXHAUST AIR INLETS:

- A. Type 'E1':
1. Model: Titus 350FL.
  2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
  3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Surface mount to ceiling.
  4. Finish: #26 White.

### 2.05 LOUVERS

- A. Manufacturers:
1. Ruskin Company: [www.ruskin.com/#sle](http://www.ruskin.com/#sle).
  2. Greenheck: [www.greenheck.com](http://www.greenheck.com)
- B. Type: 4 inch deep frame with drainable brades, heavy channel frame, 1/2 inch square mesh screen over intake or exhaust end.
- C. Fabrication: 16 gage, 0.0598 inch (1.52 mm) thick galvanized steel thick galvanized steel welded assembly, with factory prime coat finish.
- D. Color: To be selected by Architect from manufacturer's custom range.
- E. Mounting: Furnish with interior angle flange for installation.

## **2.06 ROOF HOODS**

- A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).
- B. Fabricate of galvanized steel, minimum 16 gage, 0.0598 inch base and 20 gage, 0.0359 inch hood, or aluminum, minimum 16 gage, 0.0598 inch base and 18 gage, 0.0598 inch hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory prime coat finish.
- C. Mount unit on minimum 18 inch high curb base with insulation between duct and curb.
- D. Make hood outlet area minimum of twice throat area.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9123.

**END OF SECTION**

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**SECTION 23 4000  
HVAC AIR CLEANING DEVICES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Disposable, extended area panel filters.

**1.02 REFERENCE STANDARDS**

- A. AHRI 850 (I-P) - Performance Rating of Commercial and Industrial Air Filter Equipment 2013 (Reaffirmed 2023).
- B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Addendum (2022).
- C. UL 586 - High Efficiency, Particulate, Air Filter Units Current Edition, Including All Revisions.
- D. UL 900 - Standard for Air Filter Units Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.

**PART 2 PRODUCTS**

**2.01 FILTER MANUFACTURERS**

- A. American Filtration Inc: [www.americanfiltration.com/#sle](http://www.americanfiltration.com/#sle).
- B. AAF International/American Air Filter: [www.aafintl.com/#sle](http://www.aafintl.com/#sle).
- C. The Camfil Group: [www.camfilfarr.com/#sle](http://www.camfilfarr.com/#sle).

**2.02 DISPOSABLE, EXTENDED AREA PANEL FILTERS**

- A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
  - 1. Frame: Non-flammable.
  - 2. Nominal size: As indicated in equipment specifications or drawing schedule .
  - 3. Nominal thickness: 2 inches or 4 inches as indicated in equipment specifications or drawing schedule.
- B. Minimum Efficiency Reporting Value (MERV): 14, when tested in accordance with ASHRAE Std 52.2.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

**END OF SECTION**

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**SECTION 23 7413  
PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Packaged roof top unit.

**1.02 REFERENCE STANDARDS**

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.
- B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment 2015, with Addendum (2016).
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

**1.04 QUALITY ASSURANCE**

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

**1.05 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide a five year warranty to include coverage for refrigeration compressors.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Petra Engineering Industries: [www.petra-eng.com](http://www.petra-eng.com)
- B. Trane, a brand of Ingersoll Rand: [www.trane.com](http://www.trane.com).

**2.02 MANUFACTURED UNITS**

- A. Outdoor Rooftop Units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, mixing dampers, control devices packaged DX, and accessories.

**2.03 ROOF CURBS**

- A. Provide 12ga, 2" thick insulated full perimeter roof curb with wood flashing nailer. Curbs for new installation shall be 22" height. Curbs for replacement units to be adaptor type to fix to existing roof curb and resulting in bottom of unit being 18" above finished roof. Curb section underneath DX condensing section to be watertight and sloped for proper water drainage.

**2.04 CABINET**

- A. Materials: Formed and reinforced 2" double-wall insulated panels, injected with expandable poly-iso foam insulation, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

1. Casing frame work will be penta-post construction. Exterior panels shall be removable without affecting the structural integrity of the unit. Side and roof panels fastened and caulked to each other. All Fasteners to be stainless steel.
  2. Outside Casing: 22 gauge, aluminum panel construction
  3. Inside Casing: 22 gauge, aluminum panel construction
  4. Floor Plate: 22 gauge, aluminum panel construction
  5. All panels and doors to will be thermally broken construction
  6. Unit to be painted with electro-static, epoxy coating for all interior and exterior panels. Paint will stand up to 5,000 hr salt spray test based on ASTM-B117 testing
- B. Unit Base:
1. Shall be constructed of welded G-90 galvanized 10 gauge steel C-channel members on the full perimeter of the unit, with internal cross member supporting beams to support the internal components along the whole base length and width. Pedestal feet shall not be accepted.
  2. The base shall be coated with a double epoxy coating.
- C. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B.
1. Materials: ASTM C 1071 with coated surface exposed to air stream to prevent erosion of glass fibers.
  2. Thickness: 2" thick with expandable poly-iso foam
  3. "R" value: 11.0 at 75 deg F temperature.
  4. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
  5. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.
  6. Location and Application: Encased between outside and inside casing.
- D. Access Panels and Doors: Same materials and finishes same as cabinet (interior and exterior), complete with hinges, latches, handles, and gaskets. Access panels and doors shall be sized and located to allow periodic maintenance and inspections as shown on the drawings. Provide access panels and doors in the following locations:
1. All sections to have hinged access doors
- E. Condensate Drain Pans: Formed sections of stainless steel insulated, sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
1. Double-Wall Construction: Fill space between walls with 3# /Cu. Ft. density foam insulation and seal moisture tight.
  2. Drain Connections: Both ends of pan.
  3. Pan-Top Surface Coating: Elastomeric compound.
  4. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.
  5. Mechanical contractor is responsible to furnish and install condensate trap and drain for all equipment.

## 2.05 FAN SECTION

- A. Fan-Section Construction: Belt driven SWSI plenum fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels.
1. Mount fan with 1" open type spring vibration isolation.
- B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.

1. Panel Bracing: Steel angle or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  2. Performance Class: AMCA 99-2408, Class as required.
- C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower
- D. The fan shall be isolated from the unit casing by a canvas connection to the inside of the unit casing in case of a SWSI plenum type fan.
- E. Coatings: As required and/or specified
- F. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
  2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- G. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
1. Roller-Bearing Rating Life: ABMA 11,  $L_{10}$  of 200,000 hours.
  2. Extended lube lines to the external wall of the AHU cabinet.
- H. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation and with 1.5 service factor based on fan motor.
1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  2. Motor Sheaves: Adjustable pitch for use with 15-hp motors and smaller; fixed pitch for use with motors larger than 15 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
  3. Belts: Oil resistant, non-sparking, and non-static; matched for multiple belt drives.
  4. Motor Mount: Adjustable for belt tensioning.
- I. Fan-Section Source Quality Control:
1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
  2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
- J. Exhaust fans to be propeller type direct drive fans.

## **2.06 MOTORS:**

- A. General: Comply with requirements in Division 23 Section "Motors".
- B. Motors shall be premium efficient E+ with class B insulation
- C. Motor wiring shall be brought back to control panel located at the external on the external casing of the unit.
- D. Units will be provided with variable speed drives on motors. See "Specification 238505 - Variable Speed Drive System" for further details
- E. Units will be provided with single point electrical connection with integral disconnect.

## 2.07 COILS

- A. Direct Expansion Coils shall be manufactured from seamless copper tubing, .025 inch wall thickness, 3/8 inch diameter tubing, and tested at 450psi air pressure under water.
- B. Heating Glycol/Water Coils shall be manufactured from seamless copper tubing, 0.020" wall thickness, 5/8" diameter tubing, and tested at 450 psi air pressure under water.
  - 1. Piping Connections: Threaded
  - 2. Tubes: Copper with minimum wall thickness of 0.020"
  - 3. Fins Aluminum with 0.0075" thickness
  - 4. Fin and Tube Joint: Silver brazed
  - 5. Headers: Cast iron or copper with vents and drainable connection
  - 6. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410
  - 7. Working-Pressure Ratings: 150psig
  - 8. Source Quality Control: Test to 450 psig
  - 9. Coil grommet - Where coil connections extend through the unit casing, a double grommet system shall be used to prevent air leakage. Maximum air leakage shall be no more than 25 CFM @ 3.0" W.C.
- C. Coil Sections: Common or individual, insulated, galvanized-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils. Retain one of three options in paragraph below.

## 2.08 DIRECT EXPANSION SECTION

- A. The condenser unit and evaporator coil of the air conditioning unit shall be matched per ARI Standards and the entire system shall meet or exceed minimum energy efficiency rating as scheduled
- B. Condenser coil shall be of nonferrous construction with aluminum plate fins mechanically bonded to seamless copper tube.
- C. Condenser fans shall be direct drive, propeller type for vertical discharge. Fan motors shall include permanently lubricated bearings, thermal protection, resilient mountings. Each fan shall include safety guard.
- D. Compressors shall be refrigerant R410a hermetic scroll type, with external vibration isolation, capacity control, automatically reversible oil pump and crankcase heaters.
- E. Units to be dual circuited. With digital scroll compressor on lead circuit
- F. Furnish rubber and shear vibration isolation mounting.
- G. Furnish all accessories as specified herein as shown on drawings. Including isolation valve, thermal expansion valve, electronic expansion valves (lead circuit) and loud solenoid valves.
- H. Casing shall be weatherproof unit suitable for outdoor installation, and shall be galvanized steel, zinc phosphatized and finished with baked enamel. Provide removable access panels at all locations requiring servicing.
- I. Electromechanical Controls shall be factory mounted and wired. Furnish the following:
  - 1. High/low pressure switches
  - 2. Compressor overload protection
  - 3. Time delay to prevent short cycling of compressor
  - 4. Low ambient control
  - 5. Winter start package
  - 6. Motor master control package
  - 7. Relay package including 24 Volt transformer and terminal block ready to accept field installed control wiring.

8. Low ambient cut-out to lock out compressor unit below 50°F (adjustable). Equipment supplier shall install and wire lock-out controls.

## **2.09 OUTSIDE AIR INTAKE HOODS**

- A. Units will be provided with outside air intake hoods where required. Intake hoods will have mesh filter media. Intake hoods are shipped loose for field installation.

## **2.10 EXHAUST AIR HOODS**

- A. Units will be provided with exhaust air hoods with protective bird screens. Hoods will be shipped loose for field installation

## **2.11 ECONOMIZER SECTIONS**

- A. Where required units will be provide with economizer sections Economizer will be provided with factory installed low leakage gear driven dampers on Return and Outside Air (Actuators will be provided by controls contractor) See below for damper requirements.

## **2.12 DAMPERS**

- A. General: Class 1 Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 3 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
- B. Damper Operators: Provided by controls contractor.
- C. Low-Leakage Dampers: All dampers are to be made of rigid aluminum frame with multi airfoil aluminum blades so as to reduce pressure drop and sound generated air. Opposed blade dampers rotation is achieved by PVC gears.

## **2.13 FILTER SECTION**

- A. Filters: Comply with NFPA 90A.
- B. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.
- C. Extended-Surface, Disposable Panel Filters: Factory-fabricated, dry, extended-surface filters with holding frames.
  1. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid or slide in track.
  2. Provide 2" MERV-8 Pre-filter
  3. Provide 4" MERV 13 Final-filter
- D. Filter bank shall be furnished with a Dwyer series 2000 magnehelic gage.

## **2.14 ELECTRICAL REQUIREMENTS:**

- A. Units will be provided with a single point power connection.
- B. Units will be provided with integral disconnect switch for ease of maintenance

## **2.15 CONTROLS**

- A. Units will come with out any controls. The controls contractor will furnish and install all controls
- B. All direct expansion units will come with electro-mechanical controls only, all controls for DX will be provided and installed by the controls contractor

## **2.16 AIR TO AIR RECOVERY**

- A. Heat Wheels:
  1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
    - a. Siebu Giken - Hi-Panex-Ion
  2. Casing:

- a. Steel, with manufacturer's standard paint coating.
  - b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 at 4-inch wg differential pressure.
  - c. Casing seals on periphery of rotor, on duct divider, and on purge section.
  - d. Support rotor on great-lubricate ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
3. Rotor: Aluminum, segmented wheel, strengthened with radial spokes, with nontoxic, non-corrosive, ION Absorption Type Exchange Resin. Construct media for passing maximum 500-micrometer solids.
4. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multi link belt around outside of rotor.
5. Controls:
- a. Variable frequency controller, factory mounted and wired (exhaust air sensor by controls contractor)
  - b. Low leakage recirculation damper section to be provided for morning warm up function.
  - c. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
- B. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed blade arrangement with steel operating rods rotating in nylon bearings mounted in a single extruded-aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. Ft. at 1-inch wg.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Arrange installation of units to provide access space around modular outdoor rooftop air-handling units for service and maintenance.

### **3.03 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Hot-Water Piping: Comply with applicable requirements in Division 15 Section "Hydronic Piping." Connect to supply and return coil tapings with shutoff or balancing valve and union or flange at each connection.
- D. Condensate Piping: Mechanical contractor is responsible to furnish and install condensate traps and drains on all units. Drain to discharge on roof.
- E. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
- F. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

- G. Ground equipment according to Division 26 Section "Grounding and Bonding."
- H. 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.

### **3.04 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
  - 1. Leak Test: After installation, fill water and steam coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
  - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

### **3.05 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform supervision during startup.
- B. Final Checks before Startup: Perform the following:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Perform cleaning and adjusting specified in this Section.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing 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 fully open position for each zone.
  - 7. Set face-and-bypass dampers to full face flow.
  - 8. Set outside- and return-air mixing dampers to minimum outside-air setting.
  - 9. Comb coil fins for parallel orientation.
  - 10. Install clean filters.
  - 11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
  - 12. Starting procedures for modular outdoor rooftop air-handling units include the following:
  - 13. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.[ Replace fan and motor pulleys as required to achieve design conditions].
  - 14. Measure and record motor electrical values for voltage and amperage.
  - 15. Manually operate dampers from fully closed to fully open position and record fan performance.
  - 16. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for modular outdoor rooftop air-handling system testing, adjusting, and balancing.
- C. Adjusting
  - 1. Adjust damper linkages for proper damper operation.

### **3.06 CLEANING**

- A. Clean modular outdoor rooftop air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- B. After completing system installation and testing, adjusting, and balancing modular outdoor rooftop air-handling and air-distribution systems, clean filter housings and install new filters.

### **3.07 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular indoor air-handling units.

**END OF SECTION**

**SECTION 23 8200  
CONVECTION HEATING AND COOLING UNITS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Finned tube radiation.
- B. Unit heaters.
- C. Cabinet unit heaters.
- D. Blower-coil units.
- E. Induction units.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 0716 - HVAC Equipment Insulation.
- B. Section 23 0719 - HVAC Piping Insulation.
- C. Section 23 2113 - Hydronic Piping.
- D. Section 23 2114 - Hydronic Specialties.

**1.03 REFERENCE STANDARDS**

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Current Edition.
- B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
  - 1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

**1.05 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

**PART 2 PRODUCTS**

**2.01 HYDRONIC FINNED TUBE RADIATION**

- A. Manufacturers:
  - 1. Sigma Corporation: [www.sigmaproducts.com/#sle](http://www.sigmaproducts.com/#sle).
  - 2. Slant/Fin Corporation: [www.slantfin.com/#sle](http://www.slantfin.com/#sle).
  - 3. Zehnder Rittling: [www.rittling.com/#sle](http://www.rittling.com/#sle).
- B. Required Directory Listing: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at [www.ahrinet.org](http://www.ahrinet.org).
- C. Heating Elements: 3/4 inch ID seamless copper tubing, mechanically expanded into evenly spaced aluminum fins sized 4 by 4 inches, suitable for soldered fittings.
- D. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

- E. Enclosures: 18 gage, 0.0478 inch sheet steel up to 18 inches in height, 16 gage, 0.0598 inch sheet steel over 18 inches in height or aluminum as detailed, with easily jointed components for wall to wall installation.
- F. Finish: Factory applied baked primer coat.
- G. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
- H. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

## 2.02 HYDRONIC UNIT HEATERS

- A. Manufacturers:
  - 1. Sigma Corporation: [www.sigmaproducts.com/#sle](http://www.sigmaproducts.com/#sle).
  - 2. Sterling Hydronics, a Mestek Company: [www.sterlingheat.com/#sle](http://www.sterlingheat.com/#sle).
- B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Perform factory run test under normal operating conditions, water, and steam flow rates.
- D. Casing: Minimum 18 gage, 0.0478 inch thick sheet steel casing with threaded pipe connections for hanger rods for horizontal models and minimum 18 gage, 0.0478 inch thick sheet steel top and bottom plates for vertical projection models.
- E. Finish: Factory applied baked primer coat.
- F. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- G. Air Outlet: Adjustable pattern diffuser on vertical projection models and two way louvers on horizontal projection models.
- H. Totally Enclosed Motors: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models.
- I. Electrical Characteristics:
  - 1. 120 volts, single phase, 60 Hz.

## 2.03 HYDRONIC CABINET UNIT HEATERS

- A. Manufacturers:
  - 1. Sigma Corporation: [www.sigmaproducts.com/#sle](http://www.sigmaproducts.com/#sle).
  - 2. Sterling Hydronics a Mestek Company: [www.sterlingheat.com/#sle](http://www.sterlingheat.com/#sle).
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
- C. Coils:
  - 1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
  - 2. Heating Hot Water: Suitable for working temperatures up to a maximum not less than 200 degrees F.
- D. Cabinet: Minimum 16 gage, 0.0598 inch thick sheet steel front panel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.
- E. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- F. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

- G. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- H. Control: Factory wired, solid state, infinite speed control, located in cabinet.
- I. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.
- J. Electrical Characteristics:
  - 1. 120 volts, single phase, 60 Hz.

#### **2.04 BLOWER-COIL UNITS**

- A. Manufacturers:
  - 1. International Environmental Corp.: [www.iec-okc.com/#sle](http://www.iec-okc.com/#sle).
- B. Performance Data and Safety Requirements:
  - 1. Coils rated and tested in accordance with AHRI 410.
  - 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
  - 3. Comply with NFPA 90A for unit construction, including filters and related equipment, for protection of life and property from fire, smoke, and gases resulting from conditions having manifestations similar to fire.
- C. Unit Casing:
  - 1. Fabricate from 18 heavy gage galvanized steel sheet.
  - 2. Insulate inside walls with 1 inch thick, closed cell insulation for thermal and acoustical control.
  - 3. Provide access panels allowing servicing of coils, drain pan, fan, motor, and drive.
  - 4. Provide knockouts or hanger rod holes at all four corners for suspended units.
- D. Air Coils:
  - 1. Aluminum fins mechanically expanded or bonded to 1/2 inch copper tubes having standard sweat connections.
    - a. Hot and Chilled Water: Manual, automatic or self-venting, designed to a working pressure and temperature of not less than 250 psig and 200 degrees F.
- E. Fans: Forward curved, centrifugal blower, dynamically balanced, direct drive with fan shaft supported by heavy-duty, permanently sealed ball bearings.
- F. Drain Pan: Cleanable, one-piece construction of stainless steel; with drain connection and sloped for positive drainage.
- G. Filters: Fully accessible, flat filter rack with a minimum of MERV-13 throw-away filters.
- H. Electrical:
  - 1. Provide a fused disconnecting means for main incoming power.
- I. Electrical Characteristics:
  - 1. 480 volts, three phase, 60 Hz.

#### **2.05 INDUCTION AIR UNITS**

- A. Manufacturers:
  - 1. NuClimate Air Quality Systems: [www.nu.com/#sle](http://www.nu.com/#sle).
- B. Induction beam unit shall be primary air flow units designed to induce a secondary airflow within the conditioned space using the primary conditioned air supply. Units shall be designed for ceiling installation with factory supplied hanging brackets.

- C. Units shall be equipped with a 8" round primary air intake connection , an air plenum with air induction nozzles, chilled/hot water coils, supply and return chilled water and hot water piping connections, one sloped 1-1/2 inch deep drainable condensate pan with a 3/4 inch condensate drain connection, and one combination supply/return air grille suitable for all-way blow coanda effect room air distribution. The grille shall have a hinged core to provide full access to the return air side of the coil. The unit shall be capable of inducing the secondary airflow within the conditioned space using the velocity pressure of the primary flow. This secondary air flow directly from the room to the unit and shall not use the ceiling as a return air plenum. Induction unit using the ceiling plenum as a return air path are not acceptable.
- D. A static pressure port is factory supplied on the aerodynamic inlet fitting so the balancing contractor can read via a pressure airflow guage the inlet pressure to the induction unit and set the proper pressure to meet the airflow schedules on the drawings.
- E. Each unit shall be equipped with a multiple row water coil for chilled water and hot water.
- F. Each unit shall include one drain pan and one drain pan connection. This drain pan shall be 1-1/2 inches in depth and sloped in the direction of the condensate connection. The drain outlet connection shall be 3/4 inch copper FNPT fitting.
- G. Each unit shall contain an integral factory supplied supply/return diffuser to evenly distribute the mixed primary air in an all-way blow coanda effect air distribution pattern. The diffuser shall incorporate multiple louvers in each direction for the supply air to the space. The diffuser shall fit into a standard ceiling grid. The grille return section shall be egg crate. the grille shall be hinged for easy access to the interior of the unit without tools. Access to the interior shall occur through the grille face from within the occupied space.
- H. Casings
  - 1. The entire unit shall be constructed of 20 gauge galvanized sheet metal. The primary air plenum and nozzles shall be designed and configured to provide uniform air distribution with low noise operation to all nozzles.
- I. Exterior Cabinet Insulation
  - 1. The exterior of the unit cabinet and primary air plenum shall be insulated at the factory with Armacell model AP sheet insulation. Insulation shall be 1/4 inch thick and shall meet the following criteria:
    - a. Thermal conductivity of 0.27 BTU-in/hr. ft2 F per ASTM C 177 Or C518.
    - b. Water vapor permeability of 0.08 (1.16 x 10") per ASTM E 96.
    - c. Water absorption % by volume of 0.2% per ASTM E 84.
    - d. Flame spread rating shall be 25 or less per ASTM E 84.
    - e. Smoke spread rating shall be 50 or less per ASTM E 84.
    - f. Upper temperature limit shall be 220F/105C.
    - g. Lower temperature limit shall be 70F/57C.
    - h. Specific compliance shall include ASTM C 534 Type II sheet grade 1, ASTM E 84, NFPA 255, UL 723, CAN/ULC S-102, UL94 5V-A, V-0, File E 55798, NFPA 90A, 90B, ASTM D 1056, 2B1, Mil-P-15280J Form S, Mil-C-3133C (Mil std 670B) Grade SBE 3, MEA 107-89-M, City of Los Angeles - RR 7642, CGSB Can 2-51.40-M80. ASTM C 1534.
- J. Lint Filter
  - 1. Lint filter shall be a disposable type supplied by the unit manufacture.
  - 2. Disposable panel filter shall be 1/2 inch thick fiberglass media complying with UL 217V.
- K. Induction Nozzles

1. Induction nozzles shall be aerodynamically designed and made of DuPont Hytrel 4069 Engineering Polymers with a temperature range of -40 -122 degrees F and tested and rated by test method UL94 and UL746. Each nozzle shall incorporate a tapered design allowing the airflow to enter the nozzle more effectively and perform more efficiently without dirt build up.
- L. Water Coil Assembly
1. Coils shall be of the hot and chilled water type utilizing aluminum fins and copper tubes. Coil shall be two or four pipe configuration as scheduled. Coils shall be mounted vertically not horizontally. Coil connections shall be 3/4 inch sweat connections or as indicated on drawings.
  2. Each coil must be one flat plate assemblies with no interconnecting joints to minimize leakage. Coils shall be built of minimum 1/2" seamless copper tubing. Copper tube wall shall be a minimum .016 thickness. Coils shall be factory leak tested at 350 PSI water. Each coil shall be of the fin plate design surrounding the copper tube wall via fin spacing of 11 fins per inch. Fins shall be mechanically bonded to copper tubes. Each coil shall be enclosed on the ends with sealed flanges to eliminate leakage around the coil.
- M. Additional height for gravity drain
1. To accommodate long drain line runs the Induction unit cabinet can be provided with an additional 1 to 6 inches of height. The additional height allows the drain pan connections to be 4.75 to 9.75 inches above the ceiling line instead of the standard 3.75 inch. Refer to equipment schedule on plans for which units require the extension.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

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

### **3.02 INSTALLATION**

- A. Install in accordance with manufacturer's recommendations.
- B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Finned Tube Radiation:
  1. Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated.
  2. Center elements under window with elements of equal length centered under each window for multiple windows.
  3. Install wall angles and end caps where units butt against walls.
- D. Unit Heaters:
  1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
  2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- E. Cabinet Unit Heaters:
  1. Install as indicated.
  2. Coordinate to ensure correct recess size for recessed units.
- F. Blower-Coil Units:
  1. Install in accordance with manufacturer's recommendations.
  2. General piping installation requirements are specified in other Sections and drawings indicate general arrangement of piping, fittings, and specialties.
  3. Connect hydronic, condensate drain, and overflow drain piping to unit.
- G. Induction Units:

1. Follow manufacturer's installation instructions and recommendations for all equipment.
2. Install Induction units in ceiling in such a manner as to allow easy access to all controls.
3. Use the hanging brackets on each unit which are supplied by the manufacturer. Induction units shall be supported using field supplied threaded rod.
4. Provide primary supply air connection and seal with duct sealer after installation. A volume control balancing damper shall be installed at the branch takeoffs for each induction unit for the air balancing contractor. A static pressure port is factory supplied on the aerodynamic inlet so the balancing contractor can read via a pressure airflow gauge the inlet pressure to the induction unit and set the proper pressure to meet the airflow schedules on the drawings.
5. Provide water supply / return connection and install shut off valves and temperature control valves.
6. Connect the condensate drain to available building drains if required on plans.

### **3.03 FIELD QUALITY CONTROL**

- A. Provide manufacturer's field representative to test, inspect, instruct, and observe.

### **3.04 CLEANING**

- A. After construction and painting is completed, clean exposed surfaces of units.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
- C. Install new filters.

### **3.05 CLOSEOUT ACTIVITIES**

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

**END OF SECTION**

**SECTION 23 8216  
AIR COILS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Steam coils.
- B. Electric coils.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 0719 - HVAC Piping Insulation.
- B. Section 23 2114 - Hydronic Specialties.
- C. Section 23 3100 - HVAC Ducts and Casings: Installation of duct coils.
- D. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

**1.03 REFERENCE STANDARDS**

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- C. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Sigma Corporation: [www.sigma.com/#sle](http://www.sigma.com/#sle).

**2.02 STEAM HEATING COILS**

- A. Manufacturers:
  - 1. Sigma Corporation: [www.sigma.com/#sle](http://www.sigma.com/#sle).
- B. Tubes: 5/8 inch OD seamless copper or brass arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
- C. Fins: Aluminum or copper continuous plate type with full fin collars.
- D. Casing: Die formed channel frame of 16 gage, 0.0598 inch galvanized steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.
- E. Headers: Cast iron with tubes expanded into header.
- F. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.
- G. Configuration: Drainable, with threaded plugs in headers for drain and vent, threaded plugs in return bends and in headers opposite each tube, sloped within frame to condensate connection.
- H. Fin Spacing: 8 fins per inch.

## **2.03 ELECTRIC COILS**

- A. Manufacturers:
  - 1. INDEECO (Industrial Engineering and Equipment Company); \_\_\_\_\_:  
www.indeeco.com/#sle.
- B. Assembly: UL listed and labelled, with terminal control box and hinged cover, splice box, coil, casing, and controls.
- C. Coil: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material.
- D. Casing: Die formed channel frame of 16 gage, 0.0598 inch galvanized steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.
- E. Controls: Automatic reset thermal cut-out, built-in magnetic contactors, control circuit transformer and fuse, manual reset thermal cut-out, air flow proving device, fused disconnect, load fuses.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturers written instructions.
- B. Install in ducts and casings in accordance with SMACNA (DCS).
  - 1. Support coil sections independent of piping on steel channel or double angle frames and secure to casings.
- C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- D. Make connections to coils with unions and flanges.
- E. Steam Coils:
- F. Electric Duct Coils: Wire in accordance with NFPA 70. Refer to Section 26 0583.

**END OF SECTION**

**SECTION 26 0505  
SELECTIVE DEMOLITION FOR ELECTRICAL**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Electrical demolition.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

**1.03 ADMINISTRATIVE REQUIREMENTS:**

- A. Survey and document all equipment and components scheduled for removal. Provide listing to Owner for review. Contractor is to deliver all items identified by Owner to be retained over to Owner. All other equipment and associated components shall become the Contractor's property. Contractor is responsible for prompt removal of equipment from project site in accordance with applicable federal, state, and local regulations.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

**PART 2 PRODUCTS**

**2.01 MATERIALS AND EQUIPMENT**

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

**PART 3 EXECUTION**

**3.01 EXAMINATION**

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

**3.02 PREPARATION**

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
  - 1. Notify Owner before partially or completely disabling system.
  - 2. Notify local fire service.
  - 3. Make notifications at least 24 hours in advance.
  - 4. Make temporary connections to maintain service in areas adjacent to work area.

**3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK**

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:

1. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

#### **3.04 CLEANING AND REPAIR**

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

**END OF SECTION**

**SECTION 26 0510  
BASIC ELECTRICAL REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Electrical Requirements

**1.02 RELATED REQUIREMENTS**

- A. Refer to Section 01 0000 - General Requirements.

**1.03 REFERENCE STANDARDS**

- A. The following standards shall govern and shall constitute minimum requirements as approved. If the requirements of this specification exceed those of the standards mentioned, this specification shall govern.
  - 1. Local Building Codes.
  - 2. Underwriters Laboratories, Inc., (UL) approved or listed: All materials shall be UL approved or third party certified.
  - 3. Local Electric Utility: Standards in effect on bidding date.
  - 4. Local Telephone Utility: Standards in effect on bidding date for service entrance.
  - 5. National Electrical Manufacturer's Association, NEMA: Equipment enclosures, mountings and connections.
  - 6. America National Standards Institute, ANSI: Where mentioned herein.
  - 7. American Institute of Electronic and Electrical Engineers, IEEE: Power equipment.
  - 8. National Electrical Safety Code, NESC: Outdoor and overhead work for temporary service.
  - 9. Occupational Safety and Health Act, OSHA: Requirements for safety and health of employees.
  - 10. National Fire Prevention Association, NFPA:
    - a. 70, National Electric Code, NEC.
    - b. 101, Life Safety Code.
  - 11. Building Code of New York State.
  - 12. Fire Code of New York State.
  - 13. Energy Conservation Construction Code of New York State.
  - 14. New York State Department of Labor Rules and Regulations.
  - 15. New York State Education Department "Manual of Planning Standards".
- B. References to codes, specifications, and standards called for in the specification sections and on the drawings mean, the latest edition, amendment and revision adopted by the authority have jurisdiction in effect on the date of these contract documents.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Provide all labor, items, articles, materials, operations, methods, or equipment listed, mentioned, indicated, or scheduled on the drawings and specified herein, and required to complete the electrical work.
- B. Electrical trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings.
- C. Cost of fees shall be included in the bid as follows:
  - 1. Construction permits.
  - 2. Inspections and tests as described in this section.
- D. Contract drawings and specifications are complementary and must be so construed to determine the full scope of work.
- E. Drawings:

1. Contract Drawings are, in part, diagrammatic and are intended to convey the scope of the work and indicate the general arrangement of the equipment. Follow these Drawings in laying out the work. Consult all drawings to become familiar with all conditions affecting the Work and to verify spaces in which the work will be installed.
2. Reasonable changes required by job conditions (including offsetting of conduits around beams, etc.) shall be made, after obtaining the Engineer's approval, at no additional cost to the Owner .

F. Definitions:

1. The term "provide" shall have the same meaning as "furnish and install". All materials so implied either on the drawings or in these specifications shall be furnished and installed unless specifically noted otherwise.
2. The term "circuitry" shall have the same meaning as "conductors, pathway, and all associated components required for a complete circuit".

### **1.05 SUBMITTALS**

- A. Reference Section 01 3000 - Administrative Requirements for submittal process.

### **1.06 QUALITY ASSURANCE**

A. Licensing

1. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
2. Electrical Contract Work shall be performed by, or under, the direct supervision of a Licensed Electrician.

- B. Underwriters' Certificate: Prior to submittal of Request for Final Payment, an electrical inspection certificate shall be obtained and submitted for approval. List of approved 3rd party inspecting underwriters is listed below:

1. Commonwealth of Pennsylvania Inspectors, Mike Kieff (315-408-5709).
2. Electrical Underwriters of NY, LLC (845-569-1759).
3. Inspections on Time (845-233-6711)
4. Other Underwriters are not restricted, however credentials shall be provided for Engineer approval prior to Inspection.

### **1.07 FIELD CONDITIONS**

- A. Prior to commencement of work, the Contractor(s) effecting such system shall survey all building electrical systems and components, including fire alarm, intrusion, communications, clock and computer; make written notice to the Owner regarding existing damages, missing items and incomplete systems. Prior to the conclusion of this project, the Contractor shall verify with the Project Representative that all building systems have been returned to their original conditions.
- B. Any discrepancies shall be called to the attention of the Engineer before bids are taken. Bids shall be based on code and functional adequacy. Failure of the Contractor in this respect shall not relieve him of responsibility for a fully adequate installation at no increase in cost.

## **PART 2 PRODUCTS**

### **2.01 GENERAL REQUIREMENTS**

- A. Provide new equipment and material unless otherwise called for.
- B. All equipment and/or materials shall be new and shall carry the label of Underwriter's Laboratories Inc., whenever UL requirements are applicable.
- C. Materials of same general type, such as wiring devices and luminaries, shall be of the same make throughout the building so that appearance and operation are uniform.

## **PART 3 EXECUTION**

### **3.01 CLEANING AND REPAIR**

- A. Cutting and Patching

1. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch any cut or abandoned holes left by removals of equipment, fixtures, etc. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.
- B. Contractor shall at all times keep the project free from accumulation of waste material or rubbish caused by his operation.
- C. When directed, just prior to final acceptance, clean all equipment under contract including, but not limited to the following:
  1. Lighting fixtures, panelboards, control centers, clocks, receptacles, and switch plates.
  2. All equipment to be painted, removing all rust, etc., and leave ready for painting.
  3. Building, by removing all debris, leftover conduits, wire insulation, cartons, etc., left because of this work.

**END OF SECTION**

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**SECTION 26 0526  
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
  - 1. Includes oxide inhibiting compound.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

**1.03 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 467 - Grounding and Bonding Equipment Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:

**1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Field quality control test reports.

**1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

**1.07 DELIVERY, STORAGE, AND HANDLING**

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

## **PART 2 PRODUCTS**

### **2.01 GROUNDING AND BONDING REQUIREMENTS**

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Bonding and Equipment Grounding:
  - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
  - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
  - 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
  - 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
  - 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
  - 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
- F. Communications Systems Grounding and Bonding:
  - 1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
  - 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
    - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
    - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
    - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.

### **2.02 GROUNDING AND BONDING COMPONENTS**

- A. General Requirements:
  - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
  - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
  - 1. Use insulated copper conductors unless otherwise indicated.
    - a. Exceptions:
      - 1) Use bare copper conductors where installed underground in direct contact with earth.
      - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
  2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
  3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
  4. Manufacturers - Mechanical and Compression Connectors:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com/#sle](http://www.altfab.com/#sle).
    - b. Burndy LLC: [www.burndy.com/#sle](http://www.burndy.com/#sle).
    - c. Harger Lightning & Grounding: [www.harger.com/#sle](http://www.harger.com/#sle).
    - d. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  5. Manufacturers - Exothermic Welded Connections:
    - a. Burndy LLC: [www.burndy.com/#sle](http://www.burndy.com/#sle).
    - b. Cadweld, a brand of Erico International Corporation: [www.erico.com/#sle](http://www.erico.com/#sle).
    - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: [www.thermoweld.com/#sle](http://www.thermoweld.com/#sle).
- D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
  2. Size: As indicated.
  3. Holes for Connections: As indicated or as required for connections to be made.
  4. Manufacturers:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com/#sle](http://www.altfab.com/#sle).
    - b. Erico International Corporation: [www.erico.com/#sle](http://www.erico.com/#sle).
    - c. Harger Lightning & Grounding: [www.harger.com/#sle](http://www.harger.com/#sle).
    - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: [www.thermoweld.com/#sle](http://www.thermoweld.com/#sle).
- E. Oxide Inhibiting Compound: Comply with Section 26 0519.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

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

### **3.02 INSTALLATION**

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

D. Identify grounding and bonding system components in accordance with Section 26 0553.

**3.03 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

**END OF SECTION**

**SECTION 26 0529  
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- C. Section 26 0533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- D. Section 26 5100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- E. Section 26 5600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

**1.03 REFERENCE STANDARDS**

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

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
  - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
  - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
  - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
  - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

**1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

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

#### **1.06 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

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

### **PART 2 PRODUCTS**

#### **2.01 SUPPORT AND ATTACHMENT COMPONENTS**

- A. General Requirements:
  - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
  - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of \_\_\_\_\_. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
  - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
  - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
  - 2. Conduit Clamps: Bolted type unless otherwise indicated.
  - 3. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Erico International Corporation: [www.erico.com/#sle](http://www.erico.com/#sle).
    - c. HoldRite, a brand of Reliance Worldwide Corporation: [www.holdrite.com/#sle](http://www.holdrite.com/#sle).
    - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - e. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).

- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
  - 1. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Erico International Corporation: [www.erico.com/#sle](http://www.erico.com/#sle).
    - c. HoldRite, a brand of Reliance Worldwide Corporation: [www.holdrite.com/#sle](http://www.holdrite.com/#sle).
    - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - e. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
  - 1. Comply with MFMA-4.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
  - 1. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch diameter.
    - b. Busway Supports: 1/2 inch diameter.
    - c. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
    - d. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
    - e. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
    - f. Outlet Boxes: 1/4 inch diameter.
    - g. Luminaires: 1/4 inch diameter.
- F. Anchors and Fasteners:
  - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
  - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
  - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
  - 4. Hollow Masonry: Use toggle bolts.
  - 5. Hollow Stud Walls: Use toggle bolts.
  - 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
  - 7. Sheet Metal: Use sheet metal screws.
  - 8. Wood: Use wood screws.
  - 9. Plastic and lead anchors are not permitted.
  - 10. Powder-actuated fasteners are not permitted.
  - 11. Hammer-driven anchors and fasteners are not permitted.
  - 12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    - a. Comply with MFMA-4.
    - b. Channel Material: Use galvanized steel.
    - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
  - 13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
  - 14. Manufacturers - Mechanical Anchors:
    - a. Hilti, Inc: [www.us.hilti.com/#sle](http://www.us.hilti.com/#sle).
    - b. ITW Red Head, a division of Illinois Tool Works, Inc: [www.itwredhead.com/#sle](http://www.itwredhead.com/#sle).
    - c. Powers Fasteners, Inc: [www.powers.com/#sle](http://www.powers.com/#sle).
    - d. Simpson Strong-Tie Company Inc: [www.strongtie.com/#sle](http://www.strongtie.com/#sle).

## **PART 3 EXECUTION**

### **3.01 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.

### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- 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, 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. Equipment Support and Attachment:
  - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
  - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- J. Secure fasteners according to manufacturer's recommended torque settings.
- K. Remove temporary supports.
- L. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

### **3.03 FIELD QUALITY CONTROL**

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

**END OF SECTION**

**SECTION 26 0533.13  
CONDUIT FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 07 8400 - Firestopping.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

**1.03 REFERENCE STANDARDS**

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC) 2020.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S) 2020.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT) 2020.
- E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) 2017.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit 2018.
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit 2020.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing 2021.
- J. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 1 - Flexible Metal Conduit Current Edition, Including All Revisions.
- L. UL 6 - Electrical Rigid Metal Conduit-Steel Current Edition, Including All Revisions.
- M. UL 360 - Liquid-Tight Flexible Metal Conduit Current Edition, Including All Revisions.
- N. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.
- O. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings Current Edition, Including All Revisions.
- P. UL 797 - Electrical Metallic Tubing-Steel Current Edition, Including All Revisions.
- Q. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

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

#### **1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

#### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

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

### **PART 2 PRODUCTS**

#### **2.01 CONDUIT APPLICATIONS**

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
  - 1. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
  - 2. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
- D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

- E. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- F. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
  - 1. Locations subject to physical damage include, but are not limited to:
    - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
    - b. Where exposed below 20 feet in warehouse areas.
- J. Exposed, Exterior: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.
- K. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.
- L. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
  - 1. Maximum Length: 6 feet.
- M. Connections to Vibrating Equipment:
  - 1. Dry Locations: Use flexible metal conduit.
  - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
  - 3. Maximum Length: 6 feet unless otherwise indicated.
  - 4. Vibrating equipment includes, but is not limited to:
    - a. Motors.

## 2.02 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
  - 1. Branch Circuits: 1/2 inch (16 mm) trade size.
  - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
  - 3. Control Circuits: 1/2 inch (16 mm) trade size.
  - 4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
  - 5. Underground, Interior: 3/4 inch (21 mm) trade size.
  - 6. Underground, Exterior: 1 inch (27 mm) trade size.
- E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

## 2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
  - 1. Allied Tube & Conduit, a division of Atkore International: [www.alliedeg.com/#sle](http://www.alliedeg.com/#sle).
  - 2. Nucor Tubular Products: [www.nucortubular.com/#sle](http://www.nucortubular.com/#sle).
  - 3. Western Tube, a division of Zekelman Industries: [www.westerntube.com/#sle](http://www.westerntube.com/#sle).
  - 4. Wheatland Tube, a division of Zekelman Industries: [www.wheatland.com/#sle](http://www.wheatland.com/#sle).
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  - 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
  - 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

#### **2.04 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)**

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

#### **2.05 FLEXIBLE METAL CONDUIT (FMC)**

- A. Manufacturers:
  - 1. AFC Cable Systems, Inc: [www.afcweb.com/#sle](http://www.afcweb.com/#sle).
  - 2. Electri-Flex Company: [www.electriflex.com/#sle](http://www.electriflex.com/#sle).
  - 3. International Metal Hose: [www.metalhose.com/#sle](http://www.metalhose.com/#sle).
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.

#### **2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)**

- A. Manufacturers:
  - 1. AFC Cable Systems, Inc: [www.afcweb.com/#sle](http://www.afcweb.com/#sle).
  - 2. Electri-Flex Company: [www.electriflex.com/#sle](http://www.electriflex.com/#sle).
  - 3. International Metal Hose: [www.metalhose.com/#sle](http://www.metalhose.com/#sle).

- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.

## **2.07 ELECTRICAL METALLIC TUBING (EMT)**

- A. Manufacturers:
  - 1. Allied Tube & Conduit, a division of Atkore International: [www.alliedeg.com/#sle](http://www.alliedeg.com/#sle).
  - 2. Nucor Tubular Products: [www.nucortubular/#sle](http://www.nucortubular/#sle).
  - 3. Western Tube, a division of Zekelman Industries: [www.westerntube.com/#sle](http://www.westerntube.com/#sle).
  - 4. Wheatland Tube, a division of Zekelman Industries: [www.wheatland.com/#sle](http://www.wheatland.com/#sle).
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
  - 4. Connectors and Couplings: Use compression (gland) or set-screw type.
    - a. Do not use indenter type connectors and couplings.
  - 5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

## **2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT**

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

## **2.09 ACCESSORIES**

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.
- G. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
  - 1. Products:
    - a. Menzies Metal Products; Electrical Roof Stack and Cap: [www.menzies-metal.com/#sle](http://www.menzies-metal.com/#sle).
    - b. Menzies Metal Products; Electrical Retro Box: [www.menzies-metal.com/#sle](http://www.menzies-metal.com/#sle).
- H. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
  - 1. Manufacturers:
    - a. Quickflash Weatherproofing Products, Inc: [www.quickflashproducts.com/#sle](http://www.quickflashproducts.com/#sle).
- I. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
  - 1. Products:
    - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: [www.holdrite.com/#sle](http://www.holdrite.com/#sle).

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

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

#### **3.02 INSTALLATION**

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

6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
  7. Arrange conduit to maintain adequate headroom, clearances, and access.
  8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
  9. Arrange conduit to provide no more than 150 feet between pull points.
  10. Route conduits above water and drain piping where possible.
  11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
  12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    - a. Heaters.
    - b. Hot water piping.
    - c. Flues.
  13. Group parallel conduits in the same area together on a common rack.
- G. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
  2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
  3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
  4. Use conduit strap to support single surface-mounted conduit.
    - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
  5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
  6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
  7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
  8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
  9. Use of spring steel conduit clips for support of conduits is not permitted.
  10. Use of wire for support of conduits is not permitted.
- H. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
  2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
  3. Use suitable adapters where required to transition from one type of conduit to another.
  4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
  5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
  6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
  7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.

2. Make penetrations perpendicular to surfaces unless otherwise indicated.
  3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
  4. Conceal bends for conduit risers emerging above ground.
  5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
  6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
  7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
  8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- J. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
    - a. Underground, Exterior: 24 inches.
    - b. Under Slab on Grade: 12 inches to bottom of slab.
  2. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length for service entrance where not concrete-encased.
- K. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.
- L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
  2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
  3. Where conduits are subject to earth movement by settlement or frost.
- M. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
  2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- N. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- O. Provide grounding and bonding in accordance with Section 26 0526.

### **3.03 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

### **3.04 CLEANING**

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

### **3.05 PROTECTION**

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

**END OF SECTION**

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**SECTION 26 0533.16  
BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0533.13 - Conduit for Electrical Systems:
  - 1. Conduit bodies and other fittings.
  - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 2726 - Wiring Devices:
  - 1. Wall plates.
  - 2. Floor box service fittings.
  - 3. Additional requirements for locating boxes for wiring devices.
- F. Section 27 1000 - Structured Cabling: Additional requirements for communications systems outlet boxes.

**1.03 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports 2013 (Reaffirmed 2020).
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. SCTE 77 - Specifications for Underground Enclosure Integrity 2017.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- J. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.

- K. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.
- L. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
  - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
  - 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
  - 5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
  - 6. Coordinate the work with other trades to preserve insulation integrity.
  - 7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
  - 8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### **1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 6000 - Product Requirements, for additional provisions.
  - 2. Keys for Lockable Enclosures: Two of each different key.

#### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

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

### **PART 2 PRODUCTS**

#### **2.01 BOXES**

- A. General Requirements:
  - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
  - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.

3. Provide products listed, classified, and labeled as suitable for the purpose intended.
  4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
  5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
  2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
  3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit is used.
  4. Use suitable concrete type boxes where flush-mounted in concrete.
  5. Use suitable masonry type boxes where flush-mounted in masonry walls.
  6. Use raised covers suitable for the type of wall construction and device configuration where required.
  7. Use shallow boxes where required by the type of wall construction.
  8. Do not use "through-wall" boxes designed for access from both sides of wall.
  9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
  10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
  11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
  12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
  13. 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 1000.
    - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
  14. Wall Plates: Comply with Section 26 2726.
  15. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Hubbell Incorporated; Bell Products: [www.hubbell-rtb.com/#sle](http://www.hubbell-rtb.com/#sle).
    - c. Hubbell Incorporated; RACO Products: [www.hubbell-rtb.com/#sle](http://www.hubbell-rtb.com/#sle).
    - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - e. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
  2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    - a. Indoor Clean, Dry Locations: Type 1, painted steel.
    - b. Outdoor Locations: Type 3R, painted steel.
  3. Junction and Pull Boxes Larger Than 100 cubic inches:
    - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
  4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
    - b. Back Panels: Painted steel, removable.

5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:
  - a. Cooper B-Line, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
  - b. Hoffman, a brand of Pentair Technical Products: [www.hoffmanonline.com/#sle](http://www.hoffmanonline.com/#sle).
  - c. Hubbell Incorporated; Wiegmann Products: [www.hubbell-wiegmann.com/#sle](http://www.hubbell-wiegmann.com/#sle).
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
  1. Manufacturers:
    - a. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
- E. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
  1. Manufacturers:
    - a. Appleton, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - b. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - c. Hubbell Incorporated; Killark Products: [www.hubbell-killark.com/#sle](http://www.hubbell-killark.com/#sle).
- F. Floor Boxes:
  1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 2726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
  2. Manufacturer: Same as manufacturer of floor box service fittings.
- G. Underground Boxes/Enclosures:
  1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
  2. Size: As indicated on drawings.
  3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
  4. Provide logo on cover to indicate type of service.
  5. Applications:
    - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.
    - b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 15 load rating.
    - c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
  6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
    - a. Manufacturers:
      - 1) Hubbell Incorporated; Quazite Products: [www.hubbellpowersystems.com/#sle](http://www.hubbellpowersystems.com/#sle).
      - 2) MacLean Highline: [www.macleanhighline.com/#sle](http://www.macleanhighline.com/#sle).
      - 3) Oldcastle Precast, Inc: [www.oldcastleprecast.com/#sle](http://www.oldcastleprecast.com/#sle).
    - b. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.
    - c. Product(s):
      - 1) MacLean Highline PHA Series: Straight wall, all-polymer concrete splice box/pull box; available Tier 8, Tier 15, and Tier 22 load ratings.
      - 2) MacLean Highline CHA Series: Fiberglass/polymer concrete splice box/pull box; available Tier 8 and Tier 15 load ratings.
      - 3) MacLean Highline CVA Series: Fiberglass/polymer concrete splice vault; available Tier 8, Tier 15, and Tier 22 load ratings.

## 2.02 ACCESSORIES

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

## PART 3 EXECUTION

### 3.01 EXAMINATION

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

### 3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
  - 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
  - 2. Unless dimensioned, box locations indicated are approximate.
  - 3. Locate boxes as required for devices installed under other sections or by others.
    - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726.
    - b. Communications Systems Outlets: Comply with Section 27 1000.
  - 4. Locate boxes so that wall plates do not span different building finishes.
  - 5. Locate boxes so that wall plates do not cross masonry joints.
  - 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
  - 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
  - 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
  - 9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
    - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
    - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.

10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.
  11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
    - a. Concealed above accessible suspended ceilings.
    - b. Within joists in areas with no ceiling.
    - c. Electrical rooms.
    - d. Mechanical equipment rooms.
- I. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
  2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
  3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
  4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
  2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
  3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Underground Boxes/Enclosures:
1. Install enclosure on gravel base, minimum 6 inches deep.
  2. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
- N. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- P. Close unused box openings.
- Q. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- R. Provide grounding and bonding in accordance with Section 26 0526.
- S. Identify boxes in accordance with Section 26 0553.

### **3.03 CLEANING**

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

### **3.04 PROTECTION**

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

**END OF SECTION**

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**SECTION 26 0553  
IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 09 9113 - Exterior Painting.
- B. Section 09 9123 - Interior Painting.
- C. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 26 2726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- E. Section 27 1000 - Structured Cabling: Identification for communications cabling and devices.

**1.03 REFERENCE STANDARDS**

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 969 - Marking and Labeling Systems Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
  - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
  - 2. Do not install identification products until final surface finishes and painting are complete.

**1.05 SUBMITTALS**

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

**1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.

**1.07 FIELD CONDITIONS**

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

## PART 2 PRODUCTS

### 2.01 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
    - a. Panelboards:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location when not within sight of equipment.
      - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
      - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
      - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
    - b. Enclosed switches, circuit breakers, and motor controllers:
      - 1) Identify voltage and phase.
      - 2) Identify power source and circuit number. Include location when not within sight of equipment.
      - 3) Identify load(s) served. Include location when not within sight of equipment.
    - c. Busway:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location when not within sight of equipment.
      - 4) Provide identification at maximum intervals of 40 feet.
      - 5) Use identification nameplate to identify load(s) served for each plug-in unit. Include location when not within sight of equipment.
    - d. Time Switches:
      - 1) Identify load(s) served and associated circuits controlled. Include location.
  2. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
  3. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
  4. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
  5. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
  6. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
    - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 9123 and 09 9113.
  7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
    - a. Service equipment.
    - b. Industrial control panels.
    - c. Motor control centers.

- d. Elevator control panels.
  - e. Industrial machinery.
- B. Identification for Conductors and Cables:
- 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
  - 2. Identification for Communications Conductors and Cables: Comply with Section 27 1000.
  - 3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
  - 4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
    - a. At each source and load connection.
    - b. Within boxes when more than one circuit is present.
    - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
  - 5. Use underground warning tape to identify direct buried cables.
- C. Identification for Raceways:
- 1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
  - 2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
    - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
      - 1) Color Code:
        - (a) Emergency Power System: Red.
        - (b) Fire Alarm System: Red.
      - 2) Field-Painting: Comply with Section 09 9123 and 09 9113.
      - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.
  - 3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
  - 4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
  - 5. Use underground warning tape to identify underground raceways.
  - 6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.
- D. Identification for Boxes:
- 1. Use voltage markers to identify highest voltage present.
  - 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
    - a. Color-Coded Boxes: Field-painted in accordance with Section 09 9123 and 09 9113 per the same color code used for raceways.
  - 3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
    - a. For exposed boxes in public areas, use only identification labels.
- E. Identification for Devices:
- 1. Identification for Communications Devices: Comply with Section 27 1000.
  - 2. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
  - 3. Use identification label to identify fire alarm system devices.
  - 4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.

- a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
- 5. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
- 6. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.
- F. Identification for Luminaires:
  - 1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

## 2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
  - 1. Manufacturers:
    - a. Brimar Industries, Inc: [www.brimar.com/#sle](http://www.brimar.com/#sle).
    - b. Kolbi Pipe Marker Co: [www.kolbipipemarkers.com/#sle](http://www.kolbipipemarkers.com/#sle).
    - c. Seton Identification Products: [www.seton.com/#sle](http://www.seton.com/#sle).
  - 2. Materials:
    - a. Indoor Clean, Dry Locations: Use plastic nameplates.
    - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
  - 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
    - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
  - 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
  - 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
  - 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
  - 1. Manufacturers:
    - a. Brady Corporation: [www.bradyid.com/#sle](http://www.bradyid.com/#sle).
    - b. Brother International Corporation: [www.brother-usa.com/#sle](http://www.brother-usa.com/#sle).
    - c. Panduit Corp: [www.panduit.com/#sle](http://www.panduit.com/#sle).
  - 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
    - a. Use only for indoor locations.
  - 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
  - 1. Minimum Size: 1 inch by 2.5 inches.
  - 2. Legend:
    - a. System designation where applicable:
      - 1) Emergency Power System: Identify with text "EMERGENCY".
      - 2) Fire Alarm System: Identify with text "FIRE ALARM".
    - b. Equipment designation or other approved description.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height:
    - a. System Designation: 1 inch.
    - b. Equipment Designation: 1/2 inch.

5. Color:
  - a. Normal Power System: White text on black background.
  - b. Emergency Power System: White text on red background.
- D. Format for General Information and Operating Instructions:
  1. Minimum Size: 1 inch by 2.5 inches.
  2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 1/4 inch.
  5. Color: Black text on white background unless otherwise indicated.
    - a. Exceptions:
      - 1) Provide white text on red background for general information or operational instructions for emergency systems.
      - 2) Provide white text on red background for general information or operational instructions for fire alarm systems.
- E. Format for Caution and Warning Messages:
  1. Minimum Size: 2 inches by 4 inches.
  2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 1/2 inch.
  5. Color: Black text on yellow background unless otherwise indicated.
- F. Format for Receptacle Identification:
  1. Minimum Size: 3/8 inch by 1.5 inches.
  2. Legend: Power source and circuit number or other designation indicated.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 3/16 inch.
  5. Color: Black text on clear background.
- G. Format for Control Device Identification:
  1. Minimum Size: 3/8 inch by 1.5 inches.
  2. Legend: Load controlled or other designation indicated.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 3/16 inch.
  5. Color: Black text on clear background.
- H. Format for Fire Alarm Device Identification:
  1. Minimum Size: 3/8 inch by 1.5 inches.
  2. Legend: Designation indicated and device zone or address.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 3/16 inch.
  5. Color: Red text on white background.

### **2.03 WIRE AND CABLE MARKERS**

- A. Manufacturers:
  1. Brady Corporation: [www.bradyid.com/#sle](http://www.bradyid.com/#sle).
  2. HellermannTyton: [www.hellermanntyton.com/#sle](http://www.hellermanntyton.com/#sle).
  3. Panduit Corp: [www.panduit.com/#sle](http://www.panduit.com/#sle).
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
  - 1. Do not use handwritten text.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

## **2.04 VOLTAGE MARKERS**

- A. Manufacturers:
  - 1. Brady Corporation: [www.bradyid.com/#sle](http://www.bradyid.com/#sle).
  - 2. Brimar Industries, Inc: [www.brimar.com/#sle](http://www.brimar.com/#sle).
  - 3. Seton Identification Products: [www.seton.com/#sle](http://www.seton.com/#sle).
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- D. Minimum Size:
  - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
  - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
  - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
  - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- E. Legend:
  - 1. Markers for Voltage Identification: Highest voltage present.
  - 2. Markers for System Identification:
    - a. Emergency Power System: Text "EMERGENCY".
    - b. Other Systems: Type of service.
- F. Color: Black text on orange background unless otherwise indicated.

## **2.05 UNDERGROUND WARNING TAPE**

- A. Manufacturers:
  - 1. Brady Corporation: [www.bradyid.com/#sle](http://www.bradyid.com/#sle).
  - 2. Brimar Industries, Inc: [www.brimar.com/#sle](http://www.brimar.com/#sle).
  - 3. Seton Identification Products: [www.seton.com/#sle](http://www.seton.com/#sle).
- B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
  - 1. Tape for Buried Power Lines: Black text on red background.
  - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

## **2.06 FLOOR MARKING TAPE**

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

## **2.07 WARNING SIGNS AND LABELS**

- A. Manufacturers:

1. Brimar Industries, Inc: [www.brimar.com/#sle](http://www.brimar.com/#sle).
  2. Clarion Safety Systems, LLC: [www.clarionsafety.com/#sle](http://www.clarionsafety.com/#sle).
  3. Insite Solutions, LLC: [www.stop-painting.com/#sle](http://www.stop-painting.com/#sle).
  4. Seton Identification Products: [www.seton.com/#sle](http://www.seton.com/#sle).
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
1. Materials:
    - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
    - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
  2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
  3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
    - a. Do not use labels designed to be completed using handwritten text.
  2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
  3. Minimum Size: 2 by 4 inches unless otherwise indicated.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

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

### **3.02 INSTALLATION**

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

### **3.03 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

**END OF SECTION**

**SECTION 26 0923  
LIGHTING CONTROL DEVICES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Occupancy sensors.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 0529 - Hangers and Supports for Electrical Systems
- B. Section 26 0533.16 - Boxes for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 2726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.
  - 1. Includes finish requirements for wall controls specified in this section.

**1.03 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.
- C. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts 2020.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 1472 - Solid-State Dimming Controls Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

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

**1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
  - 1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.
- C. Shop Drawings:
  - 1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
  - 2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.
- D. Field Quality Control Reports.

### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### **1.07 DELIVERY, STORAGE, AND PROTECTION**

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

### **1.08 FIELD CONDITIONS**

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

### **1.09 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all occupancy sensors.
- C. Provide two year manufacturer warranty for all daylighting controls.

## **PART 2 PRODUCTS**

### **2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS**

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.
- C. Products for Switching of Electronic Ballasts/Drivers: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

### **2.02 OCCUPANCY SENSORS**

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

3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
  4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
  5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
  6. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
  7. Sensitivity: Field adjustable.
  8. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
  9. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings.
  10. Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.
- C. Wall Switch Occupancy Sensors:
1. All Wall Switch Occupancy Sensors:
    - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
    - b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
    - c. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
    - d. Finish: Match finishes specified for wiring devices in Section 26 2726, unless otherwise indicated.
  2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
    - a. Products:
      - 1) Lutron Maestro Series; [www.lutron.com/#sle](http://www.lutron.com/#sle).
  3. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
    - a. Products:
      - 1) Lutron Maestro Series; [www.lutron.com/#sle](http://www.lutron.com/#sle).
      - 2) Substitutions: See Section 01 6000 - Product Requirements.
- D. Wall Dimmer Occupancy Sensors:
1. General Requirements:
    - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.
    - b. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
    - c. Provide field adjustable dimming preset for occupied state.
    - d. Provide fade-to-off operation to notify occupant of impending load turn-off.
    - e. Finish: Match finishes specified for wiring devices in Section 26 2726, unless otherwise indicated.

2. Passive Infrared (PIR) Wall Dimmer Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
  - a. Products:
    - 1) Lutron Maestro C.L Sensor Dimmer Series; [www.lutron.com/#sle](http://www.lutron.com/#sle).
    - 2) Lutron Maestro 0-10V Dimmer Sensor Series; [www.lutron.com/#sle](http://www.lutron.com/#sle).
- E. Ceiling Mounted Occupancy Sensors:
  1. All Ceiling Mounted Occupancy Sensors:
    - a. Description: Low profile occupancy sensors designed for ceiling installation.
    - b. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
    - c. Finish: White unless otherwise indicated.
  2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
    - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
      - 1) Products:
        - (a) Lutron LOS-CIR Series; [www.lutron.com/#sle](http://www.lutron.com/#sle).
        - (b) Lutron Radio Powr Savr Wireless Sensors; [www.lutron.com/#sle](http://www.lutron.com/#sle).
    3. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
      - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
        - 1) Products:
          - (a) Lutron LOS-CDT Series; [www.lutron.com/#sle](http://www.lutron.com/#sle).
      4. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
        - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    - F. Accessories:
      1. Provide heavy duty coated steel wire protective guards compatible with specified occupancy sensors where indicated.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

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

#### **3.02 PREPARATION**

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### 3.03 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of lighting control devices provided under this section.
  - 1. Mounting Heights: Unless otherwise indicated, as follows:
    - a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
    - b. In-Wall Time Switches: 48 inches above finished floor.
    - c. In-Wall Interval Timers: 48 inches above finished floor.
  - 2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
  - 3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 2726.
- G. Provide required supports in accordance with Section 26 0529.
- H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- I. Identify lighting control devices in accordance with Section 26 0553.
- J. Occupancy Sensor Locations:
  - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
  - 2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

### 3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Correct wiring deficiencies and replace damaged or defective lighting control devices.

### 3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.

- C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

**3.06 CLEANING**

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

**3.07 COMMISSIONING**

- A. See Section 01 9113 - General Commissioning Requirements for commissioning requirements.

**3.08 CLOSEOUT ACTIVITIES**

- A. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  - 2. Provide minimum of two hours of training.
  - 3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
  - 4. Location: At project site.

**END OF SECTION**

**SECTION 26 2416  
PANELBOARDS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 RELATED REQUIREMENTS**

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

**1.03 REFERENCE STANDARDS**

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e, with Amendment (2017).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards 2015.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- E. NEMA PB 1 - Panelboards 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less 2013.
- G. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- K. UL 67 - Panelboards Current Edition, Including All Revisions.
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.
- M. UL 869A - Reference Standard for Service Equipment Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

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

### **1.05 SUBMITTALS**

- A. See Section 01 3300 - Submittal Procedures, for submittal process.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
  - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 6000 - Product Requirements, for additional provisions.
  - 2. Panelboard Keys: Two of each different key.

### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### **1.07 DELIVERY, STORAGE, AND HANDLING**

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

### **1.08 FIELD CONDITIONS**

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

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. ABB/GE: [www.geindustrial.com/#sle](http://www.geindustrial.com/#sle).
- B. Eaton Corporation: [www.eaton.com/#sle](http://www.eaton.com/#sle).
- C. Schneider Electric; Square D Products: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
- D. Siemens Industry, Inc: [www.usa.siemens.com/#sle](http://www.usa.siemens.com/#sle).

## 2.02 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet.
  - 2. Ambient Temperature:
    - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
  - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
  - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
  - 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
  - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
  - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
  - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    - a. Indoor Clean, Dry Locations: Type 1.
    - b. Outdoor Locations: Type 3R.
  - 2. Boxes: Galvanized steel unless otherwise indicated.
    - a. Provide wiring gutters sized to accommodate the conductors to be installed.
  - 3. Fronts:
    - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
    - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
    - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
  - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Load centers are not acceptable.
- L. Provide the following features and accessories where indicated or where required to complete installation:
  - 1. Feed-through lugs.
  - 2. Sub-feed lugs.

### **2.03 POWER DISTRIBUTION PANELBOARDS**

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

### **2.04 OVERCURRENT PROTECTIVE DEVICES**

- A. Molded Case Circuit Breakers:
  - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
  - 2. Interrupting Capacity:
    - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
    - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
    - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
  - 3. Conductor Terminations:
    - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
  - 4. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
  - 5. Do not use tandem circuit breakers.
  - 6. Do not use handle ties in lieu of multi-pole circuit breakers.
  - 7. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

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

### **3.02 INSTALLATION**

- A. Perform work in accordance with NECA 1 (general workmanship).

- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- J. Provide grounding and bonding in accordance with Section 26 0526.
- K. Install all field-installed branch devices, components, and accessories.
- L. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- M. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 0573.
- N. Provide filler plates to cover unused spaces in panelboards.

### **3.03 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 200 amperes. Tests listed as optional are not required.
- D. Correct deficiencies and replace damaged or defective panelboards or associated components.

### **3.04 ADJUSTING**

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

### **3.05 CLEANING**

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

**END OF SECTION**

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## **SECTION 26 2726 WIRING DEVICES**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

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

#### **1.02 RELATED REQUIREMENTS**

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

#### **1.03 REFERENCE STANDARDS**

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for 2014h, with Amendments (2017).
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification) 2014g, with Amendment (2017).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2020).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2021.
- G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 20 - General-Use Snap Switches Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles Current Edition, Including All Revisions.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.
- L. UL 1472 - Solid-State Dimming Controls Current Edition, Including All Revisions.

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

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

### **1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Project Record Documents: Record actual installed locations of wiring devices.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 6000 - Product Requirements, for additional provisions.

### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### **1.07 DELIVERY, STORAGE, AND PROTECTION**

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

## **PART 2 PRODUCTS**

### **2.01 WIRING DEVICE APPLICATIONS**

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
- E. Provide GFCI protection for receptacles installed in kitchens.
- F. Provide GFCI protection for receptacles serving electric drinking fountains.
- G. Unless noted otherwise, do not use combination switch/receptacle devices.
- H. For flush floor service fittings, use tile rings for installations in tile floors.

### **2.02 WIRING DEVICE FINISHES**

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

### **2.03 WALL SWITCHES**

- A. Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
  - 2. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).

- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

**2.04 WALL DIMMERS**

- A. Manufacturers:
  - 1. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  - 2. Lutron Electronics Company, Inc; Maestro Series: [www.lutron.com/#sle](http://www.lutron.com/#sle).
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

**2.05 RECEPTACLES**

- A. Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
  - 2. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  - 3. Lutron Electronics Company, Inc; Designer Style: [www.lutron.com/#sle](http://www.lutron.com/#sle).
  - 4. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
  - 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
  - 1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
  - 2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
  - 3. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
  - 1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
    - a. Provide test and reset buttons of same color as device.
  - 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
    - a. Products:
      - 1) Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).

3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

## **2.06 WALL PLATES**

- A. Manufacturers:
  1. Hubbell Incorporated: [www.hubbell-wiring.com/#sle](http://www.hubbell-wiring.com/#sle).
  2. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  3. Lutron Electronics Company, Inc: [www.lutron.com/#sle](http://www.lutron.com/#sle).
  4. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).
  5. Substitutions: See Section 01 6000 - Product Requirements.
  6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.
  1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
  2. Size: Standard.
  3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

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

### **3.02 PREPARATION**

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### **3.03 INSTALLATION**

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
  1. Mounting Heights: Unless otherwise indicated, as follows:
    - a. Wall Switches: 48 inches above finished floor.
    - b. Wall Dimmers: 48 inches above finished floor.
    - c. Receptacles: 18 inches above finished floor or 6 inches above counter.
  2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.

3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
  4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
  5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
  - D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
  - E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
  - F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
  - G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
  - H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
  - I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
  - J. Install wall switches with OFF position down.
  - K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
  - L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
  - M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
  - N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
  - O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
  - P. Identify wiring devices in accordance with Section 26 0553.

### **3.04 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

### **3.05 ADJUSTING**

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

**3.06 CLEANING**

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

**END OF SECTION**

## **SECTION 26 2816.16 ENCLOSED SWITCHES**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Enclosed safety switches.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

#### **1.03 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum) 2013.
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- H. UL 98 - Enclosed and Dead-Front Switches Current Edition, Including All Revisions.

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

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

#### **1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Project Record Documents: Record actual locations of enclosed switches.
- D. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

#### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.

- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### **1.07 DELIVERY, STORAGE, AND HANDLING**

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

### **1.08 FIELD CONDITIONS**

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

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. ABB/G: [www.electrification.us.abb.com/#sle](http://www.electrification.us.abb.com/#sle).
- B. Eaton Corporation: [www.eaton.com/#sle](http://www.eaton.com/#sle).
- C. Schneider Electric; Square D Products: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
- D. Siemens Industry, Inc: [www.usa.siemens.com/#sle](http://www.usa.siemens.com/#sle).
- E. Substitutions: See Section 01 6000 - Product Requirements.
- F. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

### **2.02 ENCLOSED SAFETY SWITCHES**

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet.
  - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
  - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

- J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
  - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    - a. Indoor Clean, Dry Locations: Type 1.
    - b. Outdoor Locations: Type 3R.
- K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- L. Heavy Duty Switches:
  - 1. Comply with NEMA KS 1.
  - 2. Conductor Terminations:
    - a. Provide mechanical lugs unless otherwise indicated.
    - b. Lug Material: Copper, suitable for terminating copper conductors only.
  - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

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

**3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Identify enclosed switches in accordance with Section 26 0553.

**3.03 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

**3.04 ADJUSTING**

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

**3.05 CLEANING**

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

**END OF SECTION**

**SECTION 26 5100  
INTERIOR LIGHTING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Interior luminaires.
- B. Accessories.

**1.02 RELATED REQUIREMENTS**

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

**1.03 REFERENCE STANDARDS**

- A. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products 2019.
- B. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources 2021.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- D. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems 2006.
- E. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems 2006.
- F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012 (Reaffirmed 2018).
- G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 844 - Luminaires for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.
- I. UL 1598 - Luminaires Current Edition, Including All Revisions.
- J. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
  - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
  - 3. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

**1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:
  - a. Include estimated useful life, calculated based on IES LM-80 test data.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  1. See Section 01 6000 - Product Requirements, for additional provisions.
- D. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

#### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.

#### **1.07 DELIVERY, STORAGE, AND PROTECTION**

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

#### **1.08 FIELD CONDITIONS**

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

#### **1.09 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

### **PART 2 PRODUCTS**

#### **2.01 LUMINAIRE TYPES**

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

#### **2.02 LUMINAIRES**

- A. Manufacturers:
  1. Acuity Brands, Inc: [www.acuitybrands.com/#sle](http://www.acuitybrands.com/#sle).
  2. Alloy LED; [www.alloyled.com/#sle](http://www.alloyled.com/#sle).
  3. California Accent Lighting, Inc; [www.calilighting.com/#sle](http://www.calilighting.com/#sle).
  4. Cooper Lighting, a division of Cooper Industries: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Recessed Luminaires:
  1. Ceiling Compatibility: Comply with NEMA LE 4.
  2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
- I. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.
- J. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
  2. Tested in accordance with IES LM-79 and IES LM-80.
  3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- K. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

### **2.03 ACCESSORIES**

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
- C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

### **3.02 PREPARATION**

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### **3.03 INSTALLATION**

- A. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Suspended Ceiling Mounted Luminaires:
  1. Do not use ceiling tiles to bear weight of luminaires.
  2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
  3. Secure surface-mounted and recessed luminaires to building structure.
  4. Secure pendant-mounted luminaires to building structure.
  5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
  6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.

7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- H. Recessed Luminaires:
  1. Install trims tight to mounting surface with no visible light leakage.
  2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
  3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Suspended Luminaires:
  1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
  2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
  3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
  4. Install canopies tight to mounting surface.
  5. Unless otherwise indicated, support pendants from swivel hangers.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K. Install accessories furnished with each luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.
- M. Identify luminaires connected to emergency power system in accordance with Section 26 0553.
- N. Install lamps in each luminaire.
- O. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

### **3.04 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

### **3.05 ADJUSTING**

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

### **3.06 CLEANING**

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

### **3.07 CLOSEOUT ACTIVITIES**

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace all lamps that have failed.

**3.08 PROTECTION**

- A. Protect installed luminaires from subsequent construction operations.

**END OF SECTION**

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**SECTION 26 5600  
EXTERIOR LIGHTING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 REFERENCE STANDARDS**

- A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.
- B. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources 2021.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- D. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems 2000 (Reaffirmed 2006).
- E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1598 - Luminaires Current Edition, Including All Revisions.
- G. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
  - 2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal process.
- B. Shop Drawings:
  - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
  - 2. Provide structural calculations for each pole.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
  - 1. LED Luminaires:
    - a. Include estimated useful life, calculated based on IES LM-80 test data.
    - b. Include IES LM-79 test report upon request.
  - 2. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.
- D. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
- E. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 6000 - Product Requirements, for additional provisions.
  - 2. Furnish 5% of each plastic lens type, minimum (1) for each type.
  - 3. Furnish 10% replacement lamps for each lamp type, minimum (1) for each type.
  - 4. Furnish 10% of each driver type, minimum two (2) for each type.

#### **1.05 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

#### **1.07 WARRANTY**

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

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Acuity Brands, Inc: [www.acuitybrands.com](http://www.acuitybrands.com).
- B. Cooper Lighting, a division of Cooper Industries: [www.cooperindustries.com](http://www.cooperindustries.com).
- C. Hubbell Lighting, Inc: [www.hubbellighting.com](http://www.hubbellighting.com).

#### **2.02 LUMINAIRE TYPES**

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

#### **2.03 LUMINAIRES**

- A. Manufacturers:
  - 1. Acuity Brands, Inc: [www.acuitybrands.com/#sle](http://www.acuitybrands.com/#sle).
  - 2. Alloy LED; [www.alloyled.com/#sle](http://www.alloyled.com/#sle).
  - 3. Cooper Lighting, a division of Cooper Industries: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including modules, drivers, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- I. LED Luminaires:
  - 1. Components: UL 8750 recognized or listed as applicable.
  - 2. Tested in accordance with IES LM-79 and IES LM-80.

3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

## **2.04 POLES**

- A. All Poles:
  1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
  2. Match existing poles on site.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

### **3.02 PREPARATION**

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### **3.03 INSTALLATION**

- A. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Pole-Mounted Luminaires:
  1. Foundation-Mounted Poles:
    - a. Use existing concrete base for pole installation. Clean surface as required for proper installation of grout.
    - b. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
    - c. Tighten anchor bolt nuts to manufacturer's recommended torque.
    - d. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
  2. Grounding:
    - a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
  3. Install separate service conductors, as necessary, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
- F. Install accessories furnished with each luminaire.
- G. Bond products and metal accessories to branch circuit equipment grounding conductor.

### **3.04 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.

- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Measure illumination levels at night with calibrated meters to verify conformance with performance requirements. Record test results in written report to be included with submittals.

**3.05 ADJUSTING**

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

**3.06 CLEANING**

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

**3.07 CLOSEOUT ACTIVITIES**

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

**3.08 PROTECTION**

- A. Protect installed luminaires from subsequent construction operations.

**3.09 SCHEDULE - SEE DRAWINGS**

**END OF SECTION**

**SECTION 27 0511  
REQUIREMENTS FOR COMMUNICATIONS SYSTEMS**

**PART 1 GENERAL**

**1.01 DESCRIPTION**

- A. This Section, Requirements for Communications Installations, applies to all sections of Division 27.
- B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, and other items and arrangements for the specified items are shown on drawings.

**1.02 MINIMUM REQUIREMENTS**

- A. References to industry and trade association standards and codes are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

**1.03 RELATED REQUIREMENTS**

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

**1.04 QUALIFICATIONS (PRODUCTS AND SERVICES)**

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
  - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  - 2. The Owner reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

**1.05 MANUFACTURED PRODUCTS**

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
  - 1. Components of an assembled unit need not be products of the same manufacturer.
  - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
  - 3. Components shall be compatible with each other and with the total assembly for the intended service.
  - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:

1. The Owner shall have the option of witnessing factory tests. The contractor shall notify the Owner a minimum of 15 working days prior to the manufacturers making the factory tests.
2. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of the tests.
3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Owner.

#### **1.06 EQUIPMENT REQUIREMENTS**

- A. Where variations from the contract requirements are requested in accordance with the GENERAL CONDITIONS, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

#### **1.07 EQUIPMENT PROTECTION**

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
  1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  2. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
  3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
  4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

#### **1.08 WORK PERFORMANCE**

- A. Job site safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by GENERAL CONDITIONS.
- D. Coordinate location of equipment and pathways with other trades to minimize interferences. See the GENERAL CONDITIONS.

#### **1.09 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Inaccessible Equipment:
  1. Where the Owner determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
  2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

#### **1.10 EQUIPMENT IDENTIFICATION**

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.

- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

### 1.11 SUBMITTALS

- A. Submit in accordance with GENERAL CONDITIONS.
- B. The Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
  - 1. Mark the submittals, "SUBMITTED UNDER SECTION \_\_\_\_\_".
  - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  - 3. Submit each section separately.
- E. The submittals shall include the following:
  - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
  - 2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
  - 3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- F. Manuals: Submit in accordance with GENERAL CONDITIONS.
  - 1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
  - 2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
  - 3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
  - 4. The manuals shall include:
    - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
    - b. A control sequence describing start-up, operation, and shutdown.
    - c. Description of the function of each principal item of equipment.
    - d. Installation and maintenance instructions.

- e. Safety precautions.
  - f. Diagrams and illustrations.
  - g. Testing methods.
  - h. Performance data.
  - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
  - j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.

**1.12 TRAINING**

- A. Training shall be provided in accordance with the GENERAL CONDITIONS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Engineer at least 30 days prior to the planned training.

**END OF SECTION**

**SECTION 27 0526  
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.01 DESCRIPTION**

- A. This section specifies general grounding and bonding requirements of telecommunication installations for equipment operations.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

**1.02 RELATED WORK**

- A. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 27.
- B. Section 27 10 00, STRUCTURED CABLING: Low Voltage power and lighting wiring.

**1.03 RELATED REQUIREMENTS**

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

**1.04 SUBMITTALS**

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Engineer:
  - 1. Certification that the materials and installation is in accordance with the drawings and specifications.
  - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

**1.05 APPLICABLE PUBLICATIONS**

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. American Society for Testing and Materials (ASTM):
  - 1. B1-2001 Standard Specification for Hard-Drawn Copper Wire
  - 2. B8-2004 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 1. 81-1983 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
  - 1. 70-2005 National Electrical Code (NEC)

2. Telecommunications Industry Association, (TIA)
- D. J-STO-607-A-202 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  1. E. Underwriters Laboratories, Inc. (UL):
  2. 44-2005 Thermoset-Insulated Wires and Cables
  3. 83-2003 Thermoplastic-Insulated Wires and Cables
  4. 467-2004 Grounding and Bonding Equipment
  5. 486A-486B-2003 Wire Connectors

## **PART 1 - PRODUCTS**

### **2.01 GROUNDING AND BONDING CONDUCTORS**

- A. Telecom System Grounding Riser Conductor between the MTGB and TGB's: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 85mm<sup>2</sup> (3/0 AWG) ASTM B8 bare stranded copper grounding conductor unless indicated otherwise on drawings.
- B. Equipment grounding conductors shall be UL 83 Insulated stranded copper, except that sizes 6 mm<sup>2</sup> (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm<sup>2</sup> (4 AWG) and larger shall be permitted to be identified per NEC.
- C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.

### **2.02 GROUND RODS**

- A. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance.

### **2.03 SPLICES AND TERMINATION COMPONENTS**

- A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

### **2.04 TELECOMMUNICATION SYSTEM GROUND BUSBARS**

- A. Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 6 mm (1/4 inch) for wall and backboard mounting using standard insulators sized as follows:
  1. Main Telecom Grounding Bar (MTGB): 600 mm x 100 mm (24 inches x 4 inch). Locate in Main Electrical Service Rooms as shown on drawings.
  2. Telecom Grounding Bar (TGB) 300 mm x 100 mm (12 inches x 4 inch). Locate in Telecom Rooms as shown on drawings

### **2.05 GROUND CONNECTIONS**

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
  1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
  2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
  3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.
- C. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

## **2.06 EQUIPMENT RACK AND CABINET GROUND BARS**

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x 3/4 inch).

## **2.07 GROUND TERMINAL BLOCKS**

- A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

## **2.08 SPLICE CASE GROUND ACCESSORIES**

- A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm<sup>2</sup> (6 AWG) insulated ground wire with shield bonding connectors.

## **PART 1 - EXECUTION**

### **3.01 GENERAL**

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
  - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
  - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
  - 3. Isolation transformers and isolated power systems shall not be system grounded.
- C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

### **3.02 INACCESSIBLE GROUNDING CONNECTIONS**

- A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

### **3.03 SECONDARY EQUIPMENT AND CIRCUITS**

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
  - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
  - 2. Provide a supplemental ground electrode and bond to the grounding electrode system.
- C. Conduit Systems:
  - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
  - 2. Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
  - 3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.

- D. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- E. Boxes, Cabinets, Enclosures, and Panelboards:
  1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
  2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
  3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- F. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.
- G. Raised Floors: Provide bonding of all raised floor components. //See details on the drawings.

### **3.04 CORROSION INHIBITORS**

- A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

### **3.05 CONDUCTIVE PIPING**

- A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- B. In operating rooms and at intensive care and coronary care type beds, bond the gases and suction piping, at the outlets, directly to the room or patient ground bus.

### **3.06 TELECOMMUNICATIONS SYSTEM**

- A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.
- B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.
- D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milli ohms or less.
- E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Engineer prior to backfilling any ground connections.
- F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.
- G. Bonding Jumpers:
  1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 16 mm<sup>2</sup> (6 AWG) insulated copper wire.
  2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.

3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.
- H. Bonding Jumper Fasteners:
1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
  2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
  3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
  4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

### **3.07 COMMUNICATION ROOM GROUNDING**

- A. Telecommunications Ground Busbars:
1. Provide communications room telecommunications ground busbar hardware at 950 mm (18 inches) at locations indicated on the Drawings.
  2. Connect the telecommunications room ground busbars to other room grounding busbars as indicated on the Grounding Riser diagram.
- B. Telephone-Type Cable Rack Systems: aluminum pan installed on telephone-type cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:
1. Install a 16 mm<sup>2</sup> (6 AWG) bonding between the telecommunications ground busbar and the nearest access to the aluminum pan installed on the cable rack.
  2. Use 16 mm<sup>2</sup> (6 AWG) bonding jumpers across aluminum pan junctions.
- C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:
1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using solid copper splice plates supplied by the ground bar manufacturer.
  2. Bond together nonadjacent ground bars on equipment racks and cabinets with 16 mm<sup>2</sup> (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
  3. Provide a 16 mm<sup>2</sup> (6 AWG) bonding jumper between the rack and/or cabinet ground busbar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.
- D. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 mm<sup>2</sup> (16 AWG) bonding jumper.
- E. Other Communication Room Ground Systems: Ground all metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground busbar, whichever is closer, using insulated 16 mm<sup>2</sup> (6 AWG) ground wire bonding jumpers.

### **3.08 COMMUNICATIONS CABLE GROUNDING**

- A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.

1. At terminal points, install a cable shield bonding connector provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.
2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

### **3.09 COMMUNICATIONS CABLE TRAY SYSTEMS:**

- A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout this cable tray systems as follows:
  1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Subcontractor shall verify this loss by testing across one slice plate connection in the presence of the Contractor.
  2. Install a 16 mm<sup>2</sup> (6 AWG) bonding jumper across each cable tray splice or junction where splice plates cannot be used.
  3. When cable tray terminations to cable rack, install 16 mm<sup>2</sup> (6 AWG) bonding jumper between cable tray and cable rank pan.

### **3.10 COMMUNICATIONS RACEWAY GROUNDING**

- A. Conduit: Use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
- B. Wireway: use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.
- C. Cable Tray Systems: Use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 16 meters (50 feet).

### **3.11 GROUND RESISTANCE**

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.

### **3.12 GROUND ROD INSTALLATION**

- A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.
- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

**END OF SECTION**

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**SECTION 27 0528  
INTERIOR PATHWAYS**

**PART 1 - GENERAL**

**1.01 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for all communications cabling unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.
- C. Provide all labor, materials, tools and equipment required for the complete installation of work called for in the contract documents.

**1.02 RELATED WORK**

- A. Mounting board for communication closets.
- B. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- C. Fabrications for the deflection of water away from the building envelope at penetrations: Section 07 62 00, SHEET METAL FLASHING AND TRIM.
- D. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building
- E. Identification and painting of conduit and other devices.
- F. General electrical requirements and items that is common to more than one section of Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- G. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

**1.03 RELATED REQUIREMENTS**

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

**1.04 SUBMITTALS**

- A. In accordance with GENERAL CONDITIONS, furnish the following:
- B. Shop Drawings:
  - 1. Size and location of panels and pull boxes
  - 2. Layout of required conduit penetrations through structural elements.
  - 3. The specific item proposed and its area of application shall be identified on the catalog cuts.
- C. Certification: Prior to final inspection, deliver to the Engineer A certification that the material is in accordance with the drawings and specifications and has been properly installed.

**1.05 APPLICABLE PUBLICATIONS**

Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. National Fire Protection Association (NFPA):
  - 1. 70-05 National Electrical Code (NEC)
- B. Underwriters Laboratories, Inc. (UL):
  - 1. 1-03 Flexible Metal Conduit

2. 5-01 Surface Metal Raceway and Fittings
  3. 6-03 Rigid Metal Conduit
  4. 50-03 Enclosures for Electrical Equipment
  5. 360-03 Liquid-Tight Flexible Steel Conduit
  6. 467-01 Grounding and Bonding Equipment
  7. 514A-01 Metallic Outlet Boxes
  8. 514B-02 Fittings for Cable and Conduit
  9. 514C-05 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
  10. 651-02 Schedule 40 and 80 Rigid PVC Conduit
  11. 651A-03 Type EB and A Rigid PVC Conduit and HDPE Conduit
  12. 797-03 Electrical Metallic Tubing
  13. 1242-00 Intermediate Metal Conduit
- C. National Electrical Manufacturers Association (NEMA):
1. TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
  2. FB1-03 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

## **PART 1 - PRODUCTS**

### **2.01 CONDUIT:**

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (1/2 inch) unless otherwise shown.
1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
  2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
  3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
  4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
  5. Flexible galvanized steel conduit: Shall Conform to UL 1.
  6. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
  7. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).
  8. Surface metal raceway: Shall Conform to UL 5.

### **2.02 CONDUIT FITTINGS:**

- A. Rigid steel and IMC conduit fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
  3. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
  4. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
  5. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
  6. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
- B. Rigid aluminum conduit fittings:
1. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.

2. Locknuts and bushings: As specified for rigid steel and IMC conduit.
  3. Set screw fittings: Not permitted for use with aluminum conduit.
- C. Electrical metallic tubing fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  2. Only steel or malleable iron materials are acceptable.
  3. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
  4. Indent type connectors or couplings are prohibited.
  5. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- D. Flexible steel conduit fittings:
1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
  2. Clamp type, with insulated throat.
- E. Liquid-tight flexible metal conduit fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  2. Only steel or malleable iron materials are acceptable.
  3. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- F. Direct burial plastic conduit fittings:
1. Fittings shall meet the requirements of UL 514C and NEMA TC3.
  2. As recommended by the conduit manufacturer.
- G. Surface metal raceway fittings: As recommended by the raceway manufacturer.
1. Expansion and deflection couplings:
    - a. Conform to UL 467 and UL 514B.
    - b. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
    - c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
    - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

### **2.03 CONDUIT SUPPORTS:**

- A. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
- B. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
- C. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
- D. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

### **2.04 OUTLET, JUNCTION, AND PULL BOXES:**

- A. UL-50 and UL-514A.
- B. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
- C. Sheet metal boxes: Galvanized steel, except where otherwise shown.

- D. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.

## 2.05 WIREWAYS:

- A. Equip with hinged covers, except where removable covers are shown.

## 2.06 INNERDUCT:

- A. Standard HDPE
  - 1. Textile Innerduct : Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape as manufactured by MaxCell:
    - a. MaxCell Group/TVC Communications
    - b. 600 Plum Creek Dr.
    - c. Wadsworth, OH. 44281
    - d. 1-888-387-3828
  - 2. Textile innerduct fittings
    - a. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.: a 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
    - b. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.
    - c. Pull Tape: measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.

## 2.07 SURFACE METALLIC RACEWAY

- A. Refer to drawings for additional surface raceway sizes, cable fill tables, and cable radius requirements.
- B. TYPE SR-2 (V2400 series)
  - 1. .875" H x 1.875"W
  - 2. Metallic two piece raceway with single compartment.
  - 3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
  - 4. Refer to Drawings for additional information and requirements.
  - 5. Provide the following fittings:
    - a. Entrance end fitting - nominal maximum dimensions of 2.62"W x 2.25"H x 3" L. and 1" conduit knockout.
    - b. Back entrance end fitting - same as entrance end fitting with internal radius.
    - c. Tee fittings to connect to SR-3 (3000 Series) and SR-4 (4000 Series) raceway where T section to SR-2 (2400 Series) has maximum width equal to SR-2 raceway
    - d. Bridge fitting with radius for spanning existing raceways in varying widths from ½" to 2.
    - e. Flat Internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A. Internal or external radius control must be provided. Derate fill capacities when internal radius control is provided, as recommended by the manufacturer.
    - f. Surface 2" x 4" or 4" x 4" boxes, with 2.25" depth as called for.
  - 6. Design Make: Wiremold V2400 series raceway, V2475D series bridge fittings, V2410 series entrance end fittings, V2415 T fittings.
  - 7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.
- C. TYPE SR-3 (V3000 Series)
  - 1. 1.5" H x 2.75"W
  - 2. Metallic two piece raceway with single compartment.

3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
  4. Refer to Drawings for additional information and requirements.
  5. Provide the following fittings:
    - a. Entrance end fitting - nominal maximum dimensions of 2.75"W x 2"H x 2.125" L. and 1" conduit knockout.
    - b. Back entrance end fitting - same as entrance end fitting with internal radius.
    - c. Tee fittings to connect to SR-2 (2400 Series) raceway where T section to SR-2 has maximum width equal to SR-2 raceway
    - d. Flat Internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A using internal or external radius components. Internal or external radius control must be provided. Derate fill capacities when internal radius control is provided, as recommended by the manufacturer.
  6. Design Make: Wiremold V3000 series raceway, with V3011, V3010 and V3018 fittings.
  7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.
- D. TYPE SR-4 and SR-4d (V4000 Series)
1. 1.75" H x 4.75"W
  2. Metallic two piece raceway with single or divided compartment as called for on plans.
  3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
  4. Provide the following fittings:
    - a. Entrance end fitting - nominal maximum dimensions of 4.75"W x 2.75"H x 6.5"L. and 1.25" conduit knockout.
    - b. Back entrance end fitting - same as entrance end fitting with internal radius.
    - c. T fittings to connect to SR-2 (2400 Series) raceway where T section to SR-2 has maximum width equal to SR-2 raceway
    - d. Flat Internal and external elbows with fiber optic radius
  5. Design Make: Wiremold V4000 Series raceway, with V4010, V4017FO, V4015FO and V4011FO fittings.
  6. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal
- E. TYPE SR-7 (V700 Series)
1. One-piece raceway
  2. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
  3. Utilized for wall mounted phones and miscellaneous branch circuit power only.
  4. Provide internal and external 90 degree fittings with radius.
  5. Provide miscellaneous boxes, extension rings, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.
  6. Design Make: Wiremold V700
  7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.

## 2.08 WIRE MESH CABLE TRAY

- A. Cable Tray Finish: Carbon Steel with Zink plating.
- B. Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe/T/Edge T/welded top side wire to protect cable insulation and installers.
- C. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.
  1. Mesh: 2 x 4 inches (50 x 100 mm).
  2. Straight Section Lengths: 118 inches (3,000 mm).

3. Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray strength; and to allow tray to remain lightweight.
  4. Safe/T/Edge: Patented Safe/T/Edge technology on side wire to protect cable insulation and installers' hands.
  5. Fittings: Wire mesh cable tray fittings are field/fabricated from straight tray sections, in accordance with manufacturer's instructions and Item 2.3.
  6. CF Series Cable Tray Size:
  7. Depth: Cable tray shall be available in the following depths:
    - a. [1 inch (30 mm)]
    - b. [2 inches (54 mm)]
    - c. [4 inches (105 mm)]
    - d. [6 inches (150 mm)]
  8. Width: Cable tray width will be available in the following widths:
    - a. [2 inches (50 mm)]
    - b. [4 inches (100 mm)]
    - c. [6 inches (150 mm)]
    - d. [8 inches (200 mm)]
    - e. [12 inches (300 mm)]
    - f. [18 inches (450 mm)]
    - g. [20 inches (500 mm)]
    - h. [24 inches (600 mm)]
  9. Length: Cable tray section length will be 118 inches (3000mm) unless otherwise shown on drawings.
- D. Support cable tray as recommended by manufacture. Provide a safety loading factor of 1.5 for uniformly distributed loads when supported as a simple span in accordance with the NEMA standard listed.
- E. Refer to drawing for additional Cable Tray details and requirements
- F. Design Makes: Legrand Cablofil Wire Mesh
- G. Acceptable Manufacturers:
1. Cooper B/line Flextray
  2. Approved equal

## **2.09 CABLE HANGERS (J-HOOK)**

- A. Provide prefabricated, zinc coated, carbon steel hangers designed specifically for UTP and Optical Fiber cable installations.
- B. Hangers shall have open top, rolled edges and a 3" or 4" minimum diameter loop.
- C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.
- D. Design Make CADDY CAT CM

## **2.10 COMMUNICATIONS/POWER POLES**

- A. Provide aluminum multi-service power pole.
- B. Pole shall include 2 electrically isolated channels to act as raceway for communications cabling and future electrical wiring.
- C. Include ceiling trim plate, low voltage entrance fitting, t-bar mounting bracket and carpet / floor grippers.
- D. Design Make: Legrand TPP series or approved equal

## **2.11 FLOOR BOXES**

- A. ACCEPTABLE MANUFACTURERS
  1. FSR

- a. FL-500P-4
- b. COVER PART# FL-500P-PLP-GRY-C

## **PART 1 - EXECUTION**

### **3.01 PENETRATIONS**

- A. Cutting or Holes:
  - 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Engineer prior to drilling through structural sections.
  - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Engineer as required by limited working space.
- B. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 90 05, JOINT SEALERS.

### **3.02 INSTALLATION, GENERAL**

- A. Install conduit as follows:
  - 1. In complete runs before pulling in cables or wires.
  - 2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
  - 3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
  - 4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
  - 5. Mechanically continuous.
  - 6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
  - 7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
  - 8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
  - 9. Conduit installations under fume and vent hoods are prohibited.
  - 10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
  - 11. Flashing of penetrations of the roof membrane is specified in Section 07 62 00, SHEET METAL FLASHING AND TRIM.
  - 12. Do not use aluminum conduits in wet locations.
  - 13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.
- B. Conduit Bends:
  - 1. Make bends with standard conduit bending machines.
  - 2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
  - 3. Bending of conduits with a pipe tee or vise is prohibited.
- C. Layout and Homeruns:

1. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Engineer.

### **3.03 CONCEALED WORK INSTALLATION**

- A. In Concrete:
  1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
  2. Align and run conduit in direct lines.
  3. Install conduit through concrete beams only when the following occurs:
    - a. Where shown on the structural drawings.
    - b. As approved by the Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
  4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
    - a. Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
    - b. Space between conduits in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
    - c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (3/4 inch) of concrete around the conduits.
  5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.
- B. Furred or Suspended Ceilings and in Walls:
  1. Conduit for conductors 600 volts and below:
    - a. Rigid steel, IMC, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
  2. Align and run conduit parallel or perpendicular to the building lines.
  3. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.
  4. Tightening set screws with pliers is prohibited.

### **3.04 EXPOSED WORK INSTALLATION**

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 volts and below:
  1. Rigid steel, IMC, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- F. Surface metal raceways: Use only where shown.
- G. Painting:
  1. Paint exposed conduit.

### **3.05 EXPANSION JOINTS**

- A. Conduits 75 mm (3 inches) and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

- B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.
- C. Install expansion and deflection couplings where shown.
- D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

### **3.06 CONDUIT SUPPORTS, INSTALLATION**

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
  - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
  - 2. Existing Construction:
    - a. Steel expansion anchors not less than 6 mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.
    - b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
    - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

### **3.07 BOX INSTALLATION**

- A. Boxes for Concealed Conduits:
  - 1. Flush mounted.
  - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1".

**3.08 COMMUNICATION SYSTEM CONDUIT**

- A. Install the communication raceway system as shown on drawings.
- B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.
- C. All conduit ends shall be equipped with insulated bushings.
- D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.
- E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.
- F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.
- G. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- H. All empty conduits located in communication closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
- I. Conduit runs shall contain no more than four quarter turns (90-degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

<b>SIZES OF CONDUIT TRADE SIZE</b>	<b>RADIUS OF CONDUIT BENDS MM, INCHES</b>
<b>3/4</b>	<b>150 (6)</b>
<b>1</b>	<b>230 (9)</b>
<b>1-1/4</b>	<b>350 (14)</b>
<b>1-1/2</b>	<b>430 (17)</b>
<b>2</b>	<b>525 (21)</b>
<b>2-1/2</b>	<b>635 (25)</b>
<b>3</b>	<b>775 (31)</b>
<b>3-1/2</b>	<b>900 (36)</b>
<b>4</b>	<b>1125 (45)</b>

- J. Furnish and install 19 mm (3/4 inch) thick fire retardant plywood specified in Section 06 10 00, ROUGH CARPENTRY on the wall of communication closets where shown on drawings. Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.
- K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).
- L. Furnish SMART LB Fittings shall be utilized on all communication conduits. Refer to [www.smartlb.com](http://www.smartlb.com) for additional information. Smart LB Die cast Aluminum LB fitting shall be used with Liquidtight, "EMT", "IMC" or "Rigid" Metallic conduit and fittings. Smart LB PVC LB fitting shall be used with Sch 40 rigid PVC, "Sch 80 rigid PVC", "ENT", "PVC Flex Duct", "PVC General Purpose Duct", "PVC Riser Duct", Type NM Liquidtight conduit and "rigid nonmetallic Power and Communication Ducts"

- M. Textile Innerduct (MaxCell):
1. Aboveground, Exterior and Interior Conduit Installations: Outdoor textile innerduct (Standard or Detectable as desired).
  2. Interior Exposed Locations
    - a. Non-plenum Areas: Indoor textile innerduct
    - b. Plenum Areas: Plenum-listed indoor innerduct
  3. When installed in 4" conduit, use two 3" 3-Cell packs with an additional pull tape on the outside for future pulls in each conduit.
  4. Cable Tray: use standard outdoor or indoor textile innerduct

**END OF SECTION**

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**SECTION 27 1000  
STRUCTURED CABLING GENERAL REQUIREMENTS**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
  - 1. Contract Documents
  - 2. Division 00 –Procurement & Contracting Requirements Group
  - 3. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
  - 4. Section 27 11 00 – Equipment Room Fittings
  - 5. Section 27 13 00 – Backbone Cabling
  - 6. Section 27 15 00 – Horizontal Cabling CAT 6

**1.02 REFERENCES**

- A. All work shall be performed in accordance with the following Codes and industry Standards, unless noted otherwise:
  - 1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
  - 2. TIA/EIA 568-B – Commercial Building Telecommunications Cabling Standard, current version.
  - 3. TIA/EIA 569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
  - 4. TIA/EIA 606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
  - 5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
  - 6. IEEE 241 – IEEE Recommended Practice for Electric Power Systems in Commercial Buildings, pertaining to communication systems.
  - 7. TIA/EIA 758-A – Customer-Owned Outside Plant Telecommunications Cabling Standard

**1.03 WARRANTY**

- A. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.

**1.04 SUMMARY**

- A. This Section includes general requirements specifically applicable to Division 27.
- B. The Contractor shall be responsible for:
  - 1. Providing all additional materials, and the necessary labor and services required to ensure all components of the system are completely installed in accordance with the intent of the Contract Documents.
  - 2. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
  - 3. Coordinating the details of facility equipment and construction for all specification divisions that affect the work covered under this Division.
  - 4. Coordinating all activities with the overall construction schedule.
  - 5. Developing bill of materials, perform material management and efficient use of the materials whether they are issued by the Contractor, the owner or purchased by the Contractor.

6. Ensure materials in excess of those required to complete the project are kept in their original condition and packaging for restocking.
  7. Ensure project is properly registered for the specified manufacturer's copper & fiber cable extended warranty programs.
- C. Intent of Drawings:
1. Communications plan drawings show only general locations of equipment, devices, raceways, cable trays, boxes, etc. All dimensioned locations and elevations are approximate. The Contractor is responsible for the field coordination of communications work with the other trades prior to beginning work.
  2. The Contractor shall be responsible for the proper placement and routing of equipment, cable, raceways, cable tray, and related components according to the Contract Documents and subject to prior review by Designer.
  3. Refer all conflicts between Contract Documents to contractor for resolution.

## 1.05 DEFINITIONS

- A. Active Equipment: Electronic equipment used to develop various WAN and LAN services.
- B. Backbone: Collective term sometimes used to describe the campus and vertical distribution subsystem facilities and media interconnecting service entrances, communications rooms, and communications cabinets.
- C. Bonding: Permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed on it.
- D. Building Equipment Room (BER): Room in each building used to distribute communications services to Telecommunications Rooms (TR) in the same building. Typically, the BER contains passive equipment used for electrical protection (protectors) and building cross-connect, and active network equipment used for LANs. The BER may also serve the function of a TR.
- E. Cabinet: Freestanding, floor-mounted modular enclosure designed to house and protects rack-mounted electronic equipment.
- F. Cable Tray: Vertical or horizontal open supports usually made of aluminum or steel that is fastened to a building ceiling or wall. Cables are laid in and fastened to the trays. A cable tray is not a raceway.
- G. Campus: Grounds and buildings of a multi-building premises environment.
- H. Channel: The end-to-end transmission path between two points at which application specific equipment is connected; may include one or more links, cross-connect jumper and/or patch cords, and work area station cords. Does not include connection to active equipment.
- I. Communications Equipment Room –See Telecommunications Room (TR)
- J. Cross-Connect: Equipment used to terminate and tie together communications circuits.
- K. Cross-Connect Jumper: A cluster of twisted-pair conductors without connectors used to establish a circuit by linking two cross-connect termination points.
- L. Fiber Optic Distribution Unit (FDU): Cabinet with terminating equipment used to develop fiber optic cross-connect facilities.
- M. Grounding: A conducting connection to earth, or to some conducting body that serves in place of earth.
- N. Hinged Cover Enclosure: Wall-mounted box with a hinged cover that is used to house and protect electrical devices.
- O. Horizontal: Pathway facilities and media connecting Telecommunications Rooms (TR) to Telecommunications Outlets (TO).

- P. Innerduct: Flexible sheath used to enclose cables and protect them from damage. It is commonly used when running fiber optic cable through underground conduits originally designed for large-diameter telephone cables. Max-Cell Innerduct is a fabric based innerduct that enables a higher density of communication cables to be pulled.
- Q. Jack: Receptacle used in conjunction with a plug to make electrical contact between communications circuits, e.g., eight-position/eight-contact modular jacks.
- R. Link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables; one continuous section of conductors or fiber, including the connecting hardware at each end.
- S. Local Area Network (LAN): Data transmission facility connecting a number of communicating devices, e.g., serial data, Ethernet, token ring, etc. Typically, the network is limited to a single site.
- T. Main Equipment Room (MER): The room used to distribute communication services to all Building Equipment Rooms (BER's) on the premises, and to interconnect premises services with the telephone companies. Typically, the MER contains passive equipment used for electrical protection (protectors) and main campus cross-connect, and active equipment used for PBX, WAN, and LAN.
- U. Media: Twisted-pair, coaxial, and fiber optic cable or cables used to provide signal transmission paths.
- V. Mounting Frame: Rectangular steel framework which can be equipment rack or wall mounted to support wiring blocks, patch panels, and other communications equipment.
- W. Passive Equipment: Non-electronic hardware and apparatus, e.g., equipment racks, cable trays, electrical protection, wiring blocks, fiber optic termination hardware, etc.
- X. Patch Cords: A length of wire or fiber cable with connectors on one or both ends used to join communications circuits at a cross-connect.
- Y. Patch Panel: System of terminal blocks or connectors used with patch cords that facilitate administration of cross-connect fields.
- Z. Pathway: Facility for the placement of communications cable. A pathway facility can be composed of several components including conduit, wireway, cable tray, surface raceway, underfloor systems, raised floor, ceiling support wires, etc.
- AA. Private Branch Exchange (PBX): Private communications switching system located on the user's premises. A PBX switches voice and data calls within a building or premises and between the premises and facilities provided by public common carrier networks.
- BB. Protectors: Electrical protection devices used to limit foreign voltages on metallic communications circuits.
- CC. Raceway: An enclosed channel designed expressly for holding wires or cables; may be of metal or insulating material. The term includes conduit, tubing, wireway, underfloor raceway, and surface raceway; does not include cable tray.
- DD. Racks: An open, freestanding, floor-mounted structure, typically made of aluminum or steel, used to mount equipment; usually referred to as an equipment rack.
- EE. Telecommunication Outlet (TO): Connecting device mounted in a work area used to terminate horizontal cable and interconnect cabling with station equipment.
- FF. Telecommunications Room (TR): Distributes communications services to users within a serving zone and interconnects with the BER. Typically, the TER contains passive equipment used for cross-connect and active network equipment used for LANs. TR is sometimes referred to as the communications equipment room.

GG. Wide Area Network (WAN): Active communications transmission facilities extending beyond the premises.

HH. Wiring Block: Punch down terminating equipment used to develop twisted-pair cross-connect facilities.

## 1.06 SYSTEM DESCRIPTION

- A. The Owner will implement a comprehensive integrated communications distribution system, as described in paragraph B below, to provide wiring infrastructure which may be used to support one or more of the following services and systems:
1. Voice & Data telecommunications.
  2. Wireless systems.
  3. Facilities management systems.
- B. The communications distribution system consists of the following major subsystems, as specified elsewhere:
1. Inter-building Backbone: The inter-building subsystem refers to all twisted pair and fiber optic backbone communications cabling connecting the Main Building Equipment Room (BER) to each building equipment room (BER) in all buildings on the campus / region. This project includes modification to the campus fiber backbone as shown on the drawings and further detailed in the Specifications.
  2. The intra-building subsystem refers to all twisted pair and fiber optic backbone communications cabling connecting the Main Distribution Frame (MDF) to each building Intermediate Distribution Frame (IDF) in the buildings.
  3. Communication Rooms: The communications room contains the distribution subsystem comprised of the passive components used to terminate cabling subsystems and distribute communications services. This subsystem includes installations in the Building Equipment Rooms (BERs), in Telecommunications Rooms (TRs) and Telecommunications Enclosures (TEs). Complete work as shown in the drawings and as specified in Section 271100.
  4. Horizontal Distribution: Horizontal distribution building cable to telecommunication outlets (TOs). Section 271500 is included for termination & testing required for the installation of Cat 6 patch panels in the Telecommunications Rooms (TRs) as described by the drawings and also in the case any additional wiring is identified as necessary as a result of field conditions and approved by the Designer
  5. Work Area Distribution Subsystem: Patch cords, adapters, and devices located between the TO and station equipment. Complete work as shown in the drawings and as specified in Section 271600.
- C. The communications distribution system is based on a combination of, but not limited to, the following communications transmission technologies:
1. 100-ohm 4-pair unshielded twisted-pair cable. ( Cat 6 )
  2. 100-ohm multi-pair unshielded twisted-pair cable. (Cat 3)
  3. 8.3/125-micron singlemode fiber optic cable.
  4. 8-position telecommunications jacks.
  5. 8-position telecommunications patch panels
  6. Insulation displacement connector (IDC) type field terminated wiring blocks
  7. Outside plant copper splice enclosures
  8. Building entrance protection
  9. Factory Terminated copper patch cords
  10. Rack mount fiber optic hardware
  11. Wall mounted fiber optic hardware
  12. Fiber optic connectors & hardware
  13. Factory terminated fiber optic patch cords

- 14. Outside plant fiber splice enclosures
- D. The work locations and limits of work are shown on the drawings.

### **1.07 DESIGN CRITERIA**

- A. Compliance by the Contractor with the provisions of this specification does not relieve him of the responsibilities of furnishing materials and equipment of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.
- B. The following are incorporated into the design:
  - 1. The communications room installations are designed to be as similar as possible.
  - 2. Electrical protection is provided for all exposed inter-building twisted-pair cabling.
  - 3. The location of communication rooms is intended to restrict the maximum horizontal subsystem wiring length (defined as a channel between a telecommunications room cross-connect termination field and a served TO) to 295 feet (90 meters).

### **1.08 WARRANTY**

- A. The Contractor shall provide a manufacturer's warranty on the horizontal and backbone systems as specified in Section 27 13 00 and 27 15 00.
- B. In addition to the standard warranty requirements, the Contractor shall provide the following during the warranty period:
  - 1. Within 24 hours after notification of a defect, the Contractor shall start to make the necessary corrections and inform the appropriate Project Manager of the planned corrective actions. The Contractor shall follow this initial contact with continuous effort and complete any required corrective work within 15 days after notification.

### **1.09 QUALIFICATIONS**

- A. Communications Pathway Installation: The Contractor shall have 5 years of documented experience installing raceway and cable tray systems for each of the types and system material components specified in the Contract Documents, e.g., cable tray. In the case of newer technologies that do not have a 3-year history, the contractor shall have documented experience for at least half of the lifetime of the new technology.
- B. The Contractor selected for this project must be certified by the manufacturer of the products installed, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project.
- C. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.
- D. Company certificate & letter from manufacturer stating Contractor's certification is in good standing, shall be included with submittal.
- E. Certified Installer must register project with the specified cable manufacturers, as applicable, and must provide a warranty on the installation workmanship & testing for a length of no less than twenty (20) years.
- F. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical, Category 5e, Category 6 and Category 6a premise distribution systems and have personnel who are adequately trained in the use of such tools and equipment.
- G. A resume of qualification shall be submitted with the Contractor's proposal indicating the following:

1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
2. A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.
3. A technical resume of experience for the contractor's Project Manager and on-site installation supervisor who will be assigned to this project.
4. A list of technical product training attended by the contractor's personnel that will install the structured cabling system shall be submitted with the response.
5. Any sub-contractors, who will assist the Contractor in performance of this work, shall have the same training and certification as the Contractor.

#### **1.10 SUBMITTALS**

- A. General:
  1. Provide ongoing inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
  2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of same are clearly indicated and non-applicable portions clearly deleted or crossed out.
  3. When the specifications include product descriptions, model numbers, part numbers, etc. that have been superseded, changed, or discontinued, the contractor shall submit a comparable substitution for review by the A/E.
  4. The specified manufacturer's copper & fiber cable extended warranty program certificates stating that the communications installer is in good standing in applicable program.
- B. Provide all applicable portions of the following information with the Bid:
  1. Documentation establishing qualifications to perform installation functions as required in 1.9 above:
  2. Statement demonstrating an understanding of project scope and schedule which includes the following information:
    - a. Where (city, office) the project will be staffed.
    - b. Project organizational chart with team names; e.g., project manager, A/Es, principal skilled technicians, and contractors.
- C. Provide all applicable portions of the following information within 10 days after award:
  1. Project schedule in hard copy. Include, at a minimum, major tasks, milestones, dependencies, staffing, and durations for each task.
  2. Contractor shall then work with contractor to merge this schedule into the overall construction schedule.
  3. Provide the following information for materials, components, and equipment to be furnished by the contractor:
    - a. Descriptive literature, manufacturer's specification data sheets, and manuals.
    - b. Individual price and delivery schedules.
    - c. Manufacturer's product test data with indicator arrows. The submittal shall be in the same order as products in 27 11 00, 27 13 00 and 271600.
    - d. Final Performance testing criteria and data for communications distribution system cabling systems.

#### **1.11 DEFINITION OF ACCEPTANCE**

- A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:
  1. All submittals and documentation have been submitted, reviewed, and approved.
  2. The complete system has successfully completed all testing requirements.
  3. All Owner staff personnel training programs have been completed.
  4. All punch list items have been corrected and accepted.

5. Project registration for warranty by manufacturer.

## **1.12 PROJECT RECORD DOCUMENTS**

- A. Provide detailed project record documentation within 30 days after completion of the work.
  1. Maintain separate sets of red-lined record drawings for the communications work which show the exact placement and identification of as-built system components.
  2. Provide communication pathway record drawings which indicate exact placement and routing for all components, e.g., maintenance holes, handholes, conduit, wireway, cable tray, pull boxes, enclosures, telecommunications outlet boxes, etc.
  3. Provide communication room record drawings which indicate exact placement for all components; e.g., conduit, wireway, cable tray, backboards, equipment cabinets, equipment racks, cross-connect equipment, etc.
  4. Provide communication wiring and cabling record "As-Builds" drawings and schedules which indicate exact placement, cable foot marking, routing, and connection details for all components, e.g., twisted-pair and fiber optic cables, splices, cable cross-connect termination locations, enclosures, telecommunications outlets, cross-connect jumpers, patch cords, etc.
  5. Provide network schematics when appropriate.

## **PART 2 PRODUCTS**

### **2.01 APPROVALS AND SUBSTITUTIONS**

- A. Equivalent product(s) may be considered for substitution for those products specified, however, the equivalent product(s) must be approved and show demonstrated and documented equivalence to the product(s) specified. Documentation shall include, but is not limited to: product samples, data sheets, and actual test data. The request for product substitution, and supporting documentation, must be submitted, in writing, prior to submitting the bid. Written approval for product substitution must be submitted with the bid.

## **PART 3 EXECUTION**

### **3.01 WORKMANSHIP**

- A. Manufactured products, materials, equipment, and components shall be provided, conditioned, applied, installed, connected, and tested in accordance with the manufacturer's specifications and printed instructions
- B. The installation of all system components shall be carried out under the direction of qualified personnel. Appearance shall be considered as important as mechanical and electrical efficiency. Workmanship shall meet or exceed industry standards.

### **3.02 SERVICE CONTINUITY**

- A. Maintain continuity of communications services to all functioning portions of the process or buildings during hours of normal use.
- B. Arrange temporary outages for cutover work with electrical contractor or general contractor. Keep outages to a minimum number and a minimum length of time in order to provide minimum impact.

### **3.03 LAYOUT AND TOLERANCES**

- A. Follow as closely as practicable the design shown on the drawings. Make all necessary measurements in the field to verify exact locations and ensure precise location and fit of specified items in accordance with the drawings. Make no substantial alterations without prior approval of the Designer and the A/E.

- B. Perform all work to the lines, grades, and elevations indicated on the drawings. Provide experienced, competent personnel to locate and lay out the work and provide them with suitable tools, equipment, and other materials required to complete layout and measurement work. Use lasers or other approved methods to establish line and grade.

### **3.04 CONSTRUCTION REVIEW**

- A. The A/E and the Designer will review and observe installation work to ensure compliance by the Contractor with requirements of the Contract Documents.
- B. The Contractor shall inspect and test completed communications installations to demonstrate specified performance levels including the following:
  - 1. Furnish all instruments and personnel required for the inspections and tests.
  - 2. Perform tests in the presence of the A/E and Designer.
  - 3. Demonstrate that the system components operate in accordance with the Contract Documents.
- C. Review, observation, assistance, and actions by the Architect/Engineer (A/E) or General Contractor (GC) shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The A/E's and General Contractor's review and observation activities shall not relieve the contractor from the responsibilities of these Contract Documents.
- D. The fact that the A/E, GC or the owner does not make early discovery of faulty or omitted work shall not bar the A/E, GC or the owner from subsequently rejecting this work and insisting that the contractor make the necessary corrections.
- E. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the A/E, GC or the Owner for an increase in the Subcontract price, or for any payment on account of increased cost, damage, or loss.

**END OF SECTION**

**SECTION 27 1500  
HORIZONTAL CABLING - CAT 6**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Horizontal (distribution) communications wiring and connecting hardware from the Telecommunications Room (MDF, IDF) to Telecommunication Outlets / Network Jacks throughout the site.
- B. Cat 6A cabling and associated jacks shall be used for all network devices, IP Cameras, IP Phones, Wireless Access Points, Door Access Controllers, IP Sound System equipment, analog phone lines and as further shown on the drawings.
- C. All Horizontal Station wiring shall be Plenum Rated (CMP).

**1.02 RELATED DOCUMENTS**

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
  - 1. Contract Documents.
  - 2. Division 00 – Procurement & Contracting Requirements.
  - 3. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
  - 4. Section 27 10 00 – Structured Cabling General Requirements.
  - 5. Section 27 05 26 – Grounding and Bonding for Communications Systems.
  - 6. Section 27 11 00 –Equipment Room Fittings.

**1.03 REFERENCES**

- A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
  - 1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
  - 2. TIA/EIA-568-B – Commercial Building Telecommunications Cabling Standard, current version.
  - 3. TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
  - 4. TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
  - 5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
  - 6. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings pertaining to communication systems.

**1.04 SYSTEM DESCRIPTION**

- A. The horizontal distribution subsystem refers to all intra-building twisted-pair and fiber optic communications cabling connecting Telecommunication Rooms (MTR, ITR's) to telecommunication outlets / network jacks located at individual work areas.
- B. Horizontal cabling may consist of a combination of the following types of cable:
  - 1. Category 6A, (100 Ohm, 4-pair, unshielded twisted pair) cables.
- C. The Horizontal System includes cables, jacks, patch panels, connecting blocks, patch cords, fiber connectors and jumpers as well as the necessary support systems, such as cable managers and faceplates.
- D. Cables may be routed through conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above ceiling tile, and through plenum air-handling spaces above ceiling tile. Coordinate with General Contractor (GC).

1. Furnish and install all materials necessary for a complete and working system.
- E. All Horizontal Station wiring shall be Plenum Rated (CMP).

### **1.05 WARRANTY**

- A. The telecommunications contractor must be an approved certified installer of the cabling manufacturer. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the cabling manufacturer's guidelines. The certified contractor shall have 30% of their technicians trained on copper & fiber installations and testing by the cabling manufacturer.
- B. The copper warranty should guarantee installed static channel (Includes patch cords) performance above the TIA/EIA Standards for Cat 6A cabling systems. The static channel performance tests shall be performed in the field with an approved certification tester in the channel test configuration.
- C. Warranty period shall be for one (1) year.

## **PART 2 PRODUCTS**

### **2.01 APPROVALS AND SUBSTITUTIONS**

- A. All products shall be provided as specified, unless an approved equal is provided.
- B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).
- C. All products shall be "NEW".

### **2.02 STATION CABLING**

- A. Category 6 unshielded twisted pair (Superior Essex DataGain Category 6+)
  1. 100 ohm, Category 6A, 22AWG, 4-pair unshielded twisted pair, CMP rated.
    - a. Maximum insertion loss of 2.0 dB/100M at 1 MHz, 19.7 dB/100M at 100 MHz, 32.6 dB/100M at 250 MHz and 48.6 dB/100M at 500 MHz.
    - b. NEXT, PSNEXT, ELFEXT, PSELFEXT margin greater than 5 dB better than ANSI/TIA/EIA category 6 standards requirement
    - c. Cable balance: LCL/TCL greater than 50 dB @ 100 m at 1 MHz, 30.0 dB @ 100m at 100 MHz and 26.0 dB @ 250 MHz. EL TCTL greater than 30 dB @ 100m at 1 MHz, and 5.5 dB @ 100m at 31.25 MHz
    - d. Electrical characteristics must be characterized to 550 MHz.
    - e. Each pair in the cable must be insulated with FEP
    - f. Cable must be third party verified by ETL.
    - g. Superior Essex DataGain Category 6+, Part No. 66-246-xB.
    - h. Color Coding of Cables / Jacks and Patch Cables to be coordinated with Owner prior to ordering. Base pricing on colors listed below

### **2.03 MODULAR JACKS**

- A. Category 6 Jacks: Provide 8 position – 8 conductor keyed, wired in accordance with ANSI/TIA T568B PIN configuration standard to terminate Category 6A UTP cables as specified herein.
  1. 8-position modular jack, Category 6A, IDC terminals, T568A/B wiring scheme
    - a. Panduit Mini-Com TX6 Plus, Part No. CJ688-TG
  2. Each jack must be stamped or have icons to identify it as CAT 6A.
    - a. Color Coding of Jacks:
      - 1) Blue: Standard Network Devices

### **2.04 FACE PLATES**

- A. Single gang face plate for modular RJ-45 inserts with built in labeling window. Color – Off White Ivory. Panduit Mini-Com Executive Series Faceplates
  1. Panduit #CFPE1-WY, 1 port

2. Panduit #CFPE2-WY, 2 port
3. Panduit #CFPE3-WY, 3 port
4. Panduit #CFPE4-WY, 4 port

B. Blank Inserts – Provide Modular Inserts for any unused face plate opening.

## **2.05 FIELD TERMINATABLE RJ45**

- A. Directly attached to Cat 6 cable for direct plug into IP Classroom Speaker Module
  1. Panduit Part No. FP6X88MTG
- B. Provide a cable label on Cat 6 cable to identify IDF patch panel port.

## **2.06 BISCUIT BLOCKS**

- A. Two Port Keystone Surface Mount Blocks
  1. 2 port, label field, surface mount, Accepts Panduit Mini-Com TX6 Plus Jacks
    - a. Panduit #CBXQ2

## **2.07 PATCH PANELS**

- A. Modular patch panels
  1. 24 port, 8-position modular jack flat panel, high density, Panduit Mini-Com, TX6A Plus Modular jacks, Strain Relief bar (#SRBS19BL-XY), 1U.
    - a. Panduit #CPPL24WBLY
  2. 48 port, 8-position modular jack flat panel, high density, Panduit Mini-Com, TX6A Plus Modular jacks, Strain Relief bar (#SRBS19BL-XY), 2U.
    - a. Panduit #CPPL48WBLY

## **2.08 PATCH CORDS/JUMPERS**

- A. Category 6 modular patch cords
  1. Factory terminated double ended, 8-position to 8-position, modular, stranded conductors, Category 6, 4 pair.
    - a. Panduit UTPSP1BUY (1 Feet):
      - 1) Blue
      - 2) Provide 10. (IP End Points & Switch connections)
    - b. Panduit UTPSP3BUY (3 Feet): Slimline Booted, Use in Telecom Closets
      - 1) Blue
      - 2) Provide 10
    - c. Panduit UTPSP6BUY (6 Feet): Slimline Booted, Use in Telecom Closets
      - 1) Blue
      - 2) Provide 10
    - d. IP Sound System: EC shall coordinate with Owner when patching into Ethernet network switches.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Horizontal cabling includes cables, jacks, patch panels, connecting blocks, and patch cords, as well as the necessary support systems, such as cable managers and faceplates.
- B. Contractor shall furnish and install all materials necessary for a complete and working system.
- C. Contractor must be a certified manufacturer installer prior to, during, and through completion of the system installation.
  1. Field terminated copper and fiber optic patch cords and jumpers shall not be allowed. All patch cords shall be pre-terminated by the manufacturer.
- D. All work shall be performed in a professional manner.
- E. Install cable after interior of building has been physically protected from the weather and all mechanical work likely to damage cabling has been completed.

- F. Before installing cabling, ensure all cable pathways are completely and thoroughly cleaned:
- G. Inspect conduit, wireway, cable trays, and innerduct installed by others.
- H. Clean any additional enclosed raceway and innerduct systems furnished.
- I. Provide protection for exposed cables where subject to damage.
- J. Provide abrasion protection for any cable or wire bundles, which pass through holes or across edges of sheet metal. Protective bushings shall be used to protect cables.
- K. Cable ties and other cable management clamps shall be no more than hand tightened and shall fit snugly, but not compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices. Plenum spaces require Plenum rated cable ties.
- L. Where possible, route cables in overhead cable trays and inside wire management systems attached to the equipment cabinets and racks. Use plastic ties or ducts to restrain cabling installed outside of wire management systems on racks or in cabinets. Cable trays shall not exceed 50% fill.
- M. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- N. Cable raceways shall not be filled greater than the TIA/EIA-569-A maximum fill for the particular raceway type.
- O. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60-inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids, plumbing pipes, and electrical conduits.
- P. Horizontal distribution cables shall be bundled in groups of no more than the amount of cables designed for by the cable support manufacturer recommends based on cable OD and weight. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- Q. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
- R. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- S. All Conduit Sleeves and wire way trays penetrating fire walls shall have 3M Fire Barrier Pillows installed. Contractor is responsible to place fire barrier pillows on all existing penetrations that will be reused to run new cable and all new penetrations required for the new cable installation. Fire barrier Pillows shall be placed per manufacturer's recommendation to create a 2-hour fire barrier.

### **3.02 UNSHIELDED TWISTED PAIR CABLE INSTALLATION PRACTICES**

- A. Cable shall be installed in accordance with manufacturer recommendations and best industry practices.
- B. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- C. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- D. The cable's minimum bend radius and maximum pulling tension shall not be exceeded Bend radius for UTP = 4 X Cable OD, FTP = 8 X Cable OD.

- E. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- F. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.  
Separation from Power Lines:
- G. Provide the following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
- H. Open or Nonmetal Communications Pathways:
  - 1. 12 inches from electric motors, fluorescent light fixtures, and unshielded power lines carrying up to 3 kVA.
  - 2. 36 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
  - 3. 48 inches from large electrical motors or transformers.
- I. Grounded Metal Conduit Communications Pathways:
  - 1. 2 1/2 inches from electrical equipment and unshielded power lines carrying up to 2 kVA.
  - 2. 6 inches from electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA.
  - 3. 12 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
  - 4. 3 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA.
  - 5. 6 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying more than 5 kVA.

### **3.03 UNSHIELDED TWISTED PAIR TERMINATION**

- A. Cables shall be coiled to house the cable coil without exceeding the manufacturers bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored; Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
- B. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B.1 document, manufacturer's recommendations and best industry practices.
- C. All 4 pair cables shall be terminated on the jack and patch panels using T568-B wiring scheme.
- D. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- E. Bend radius of the horizontal cable shall not be less than 4 times the outside diameter of the UTP cable. 8 times for FTP cables.
- F. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- G. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- H. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- I. The cable jacket shall be maintained as close as possible to the termination point. Cable shall not have more than 1.0" removed.

### **3.04 TESTING PROCEDURES**

- A. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

- B. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, the manufacturer's procedures and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.
- C. Cables, jacks, connecting blocks, and patch panels shall be in their final position with the building energized.
- D. All Unshielded Twisted Pair cables shall be tested as follows:
  - 1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using an approved certification tester (Fluke or Agilent) for category 6 performance compliance as specified in ANSI/TIA/EIA-568-B.2-1.
  - 2. Follow the Standards requirements established in ANSI/TIA/EIA-568-B .1, B.2-1.
  - 3. Testing shall be accomplished with an approved certification tester (Fluke or Agilent)
  - 4. The basic tests required are:
    - a. Wire Map
    - b. Length (feet)
    - c. Insertion Loss (dB) (Formerly Attenuation)
    - d. NEXT (Near end crosstalk) (dB)
    - e. Return Loss (dB)
    - f. ELFEXT (dB)
    - g. Propagation Delay (ns)
    - h. Delay skew (ns)
    - i. PSNEXT (Power sum near-end crosstalk loss) (dB)
    - j. PSELFEXT (Power sum equal level far-end crosstalk loss) (dB)
  - 5. Cat 6 shall be tested to a Cat 6 auto test to 250 Hz.
  - 6. All test results shall be provided in the approved certification testers original software format on a CD, with the following minimum information per cable:
    - 2.05.1.1.1.1.1 Circuit ID
    - 2.05.1.1.1.1.2 All information from 3.4D.4 above.
    - 2.05.1.1.1.1.3 Test result, "Pass" or "Fail"
    - 2.05.1.1.1.1.4 Date and Time of test
    - 2.05.1.1.1.1.5 Project Name
    - 2.05.1.1.1.1.6 NVP
    - 2.05.1.1.1.1.7 Version of software
 Note: No asterisk \* will be accepted. These results shall be retested and submitted after a PASS is received.
- E. A software copy of the test results, in the original tester software format, shall be provided to the Owner and manufacturer.
- F. Contractor shall provide a fully functional version of the tester software for use by the Owner in reviewing the test results.
- G. Any failed test results that cannot be remedied through re-termination (as in the case of reversed or split pairs), must be reported in writing to the Owner immediately, along with a copy of the test results.

**3.05 LABELING**

- A. All horizontal cables are to be labeled using a machine printed label at each end of the cable at approximately 12 inches of the termination point, and again at approximately 48 inches from the termination point. Handwritten labels shall not be used.
- B. All patch panel ports and telecommunication outlet ports shall be labeled with the cable identifier.

- C. The labels shall denote the Telecommunications outlet ID, as well as the unique cable number for that Telecom Outlet, i.e. A-001-A for cable number 1, A-001-B for cable number 2, and so forth. Owner may provide specific labeling requirements coordinate with owner.
- D. Note all labeling information on the as-built drawings.

**END OF SECTION**

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**SECTION 27 5117  
IP PUBLIC ADDRESS SYSTEM**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS**

- A. The drawings and general provisions of the Contract Documents apply to this section.

**1.02 SUMMARY**

- A. This section includes modification to existing PA system head end to accommodate new speakers:
  - 1. The system shall provide complete internal communications and clock control employing state of the art VoIP Technology including the minimum functions listed.
  - 2. Two-way Loud Speaking Internal Intercommunications.

**1.03 SUBMITTALS**

- A. Product data for each component.
- B. Shop Drawings: Prior to proceeding with the work: Provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, location of each field connection, and a complete schedule of all equipment and materials with associated manufacturers cuts sheets which are to be used.
- C. Wiring Diagrams: Detail wiring for power, signal, control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.
- D. Artwork drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.
- E. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor's name in the title block.
- F. Details and description of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.
- G. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems, which are not FCC approved or utilize an intermediary device for connection, will not be considered. Provide the FCC registration number of the system being proposed as part of the submittal process.
- H. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.
- I. Installer Certificates: Signed by manufacturers certifying that they comply with requirements.
- J. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.
- K. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- L. Maintenance Data: For equipment to be included in maintenance manuals specified in Division 1.
  - 1. Record of Owners equipment-programming option decisions.
  - 2. All instructions necessary for proper operation and manufacturer's instructions.
  - 3. "Proof of Performance" information.
  - 4. Manufacturer's maintenance information.

5. Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.
- M. Record Drawings: Prior to final acceptance, provide three (3) complete sets of drawings indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions. These Record Drawings will be used during "Final Acceptance Testing".
  - N. System Training: Submit the following information describing the training programs and system trainers as outlined in paragraph 1.6 of this specification and in accordance with Division 1 specifications.
    1. Include with the submittal a preliminary staff development training program in outline form for review and approval by the Owner's Representative.
    2. Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the project.
    3. Include with the submittal a current copy of trainer's need's assessment form which will be reviewed with the Owner's Designated Representative for the system's preliminary system programming and configuration.
    4. Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.
  - O. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary.

#### **1.04 QUALITY ASSURANCE**

- A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following within thirty (30) days after notification to proceed:
  1. Provide a list of installations that the Installer has specifically installed for verification by the Owner. Random installations from other vendors and/or Installers shall not be accepted. The Installer, not its employees, must meet these qualifications.
  2. The installer shall be bondable.
  3. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:
    - a. Adequate plant and equipment to pursue the work properly and expeditiously.
    - b. Adequate staff and technical experience to implement the work.
    - c. Suitable financial status to meet the obligations of the work.
    - d. Technically capable and factory trained service personnel at local service facility to provide routine and emergency service for all products used in this project.
- B. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of an "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer.
- C. Because the life expectancy of this type of communications system normally exceeds 10 years, the owner expects continuity from the service provider. Therefore, the installing/servicing company must have been an authorized provider of the manufacturers product for at least 10 years.
- D. Each major component of equipment shall have the manufacturers name, address and model number on a plate securely affixed in a conspicuous place. NEMA code ratings, UL Label, or other data that is die-stamped into the surface of the equipment shall be easily visible.

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA, Article 100, by testing agency acceptable to authorities having jurisdiction.
- F. Comply with NFPA 70.
- G. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.
- H. Comply with UL 60950.

**1.05 IN-SERVICE TRAINING**

- A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.
- B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.
- C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

**1.06 WARRANTY**

- A. Provide a manufacturer's five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic equipment, as well as analog clocks, speakers, and call-in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one year warranty shall be provided for labor.
- B. A copy of the manufacturer's standard statement of warranty proving all equipment provide for the school communications network is covered with the required five-year warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.
- C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hour of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.
- D. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

**1.07 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide the following system:
  1. Telecenter VoIP / Universe manufactured by Rauland-Borg Corp.

**PART 2 - PRODUCTS**

**2.01 SYSTEM REQUIREMENTS**

- A. The system shall utilize state of the art VoIP Technology, Call-in Notification, School Safety Paging and Evacuation tones, Distributed (MDF/IDF) Electronic Architecture, Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone, Two-way Loud Speaking Internal Intercommunications and Paging, and Program Distribution. The system shall be easy to learn and operate. All standard system programming shall be user friendly to allow the system administrator the ability to easily program system features.

## 2.02 EQUIPMENT AND MATERIAL

- A. Provide an integrated intercom module for individual room intercommunications, all page and zone page, evacuation tones, prerecorded messages, multilevel call-in, secondary clock correction, and class change tones. The module shall be from the same manufacturer as the VoIP Controller (Gateway) to ensure compatibility. The module shall integrate directly with the VoIP Controller and will not require analog or digital tie lines to the VoIP Controller. Module shall provide the following integrated features and functions that integrate seamlessly with the VoIP Controller:
1. Two-way communication between any telephone and any room speaker.
  2. Preannounce tone prior to connecting any intercom conversation to alert the user to the call and prevent unauthorized monitoring. A tone shall be automatically repeated at regular intervals for the duration of the intercom call if the voice circuit is not activated. A requirement to meet existing privacy laws.
  3. Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
  4. Single button access from any telephone on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers. Emergency announcements originating from any assigned administrative telephone shall have priority over all regular system functions.
  5. Single button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. Up to Sixteen (16) separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular systems functions.
  6. The system will have the ability to utilize a web-browser and USB microphone to deliver live emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The system must be capable of automatically notifying district personnel via the WAN of an alarm condition.
  7. The system can automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
  8. Multilevel call-ins can be placed from either a classroom telephone or a call-in switch. The call-ins route to select or all administrative telephones and can only be cleared from the system once answered from an administrative telephone. If a call-in is not answered within a preprogrammed time the call-in may route to other administrative telephone(s) announce over selected or all speakers and shall have the capability to also reroute calls to predefined Mobile telephones. Emergency call-ins can also be programmed to send e-mail alerts to specific addresses.
  9. An option for Privacy call-in switches. When the Privacy switch is activated, it prevents administrative or classroom telephones from monitoring the specific classroom/location intercom speaker.
  10. Classroom teachers shall have the capability to exclude pages and tones from their individual classroom for testing or other purposes. This exclusion cannot affect emergency pages. This exclusion will reset at midnight.
  11. An option for Call Assurance call-in switches. When the normal or emergency button is pressed, and LED lights up to visually confirm that a call-in has been placed.
  12. The system can automatically alter a call switch's class of service by time of day and date via the integrated master clock.

13. The capability to assign speaker locations to any one or more of the Sixteen (16) independent program/music distribution zones and sixteen (16) independent class change tone reception; this assignment is a programmable function. Each location shall be programmed in software to belong to any combination of software zones. Software/hardwired zones must be configured as part of an unlimited number of district wide groups for school district emergency announcements. These district announcements must be accessed via microphone, a web-browser or telephone.
  14. Automatic class change tones sent through all or selected intercom/paging speakers and/or horns. Any combination of up to Sixteen (16) tones can be sounded to indicate different events. Up to Sixteen (16) different class change schedules can be stored in the system and selected manually from an administrative telephone, web browser or selected automatically based on time, day of the week and date. Tone type and duration are selectable for each class change event. An unlimited number of class change events can be programmed as part of the system.
  15. Programmable "Music-on-Class-Change." A program source can be automatically routed to select zones of paging speakers or all speakers within the facility during each class change period.
  16. The system shall provide facilities to distribute program material (i.e. cassette tape, CD, radio broadcasts) in the following manner:
    - a. The user shall cue remotely located music source or select radio station.
    - b. From an Administrative Telephone the user can select the room(s) or areas to distribute program.
    - c. Automated distribution based on event schedule.
  17. The module provides for secondary clock correction with the following features and functions:
    - a. User programmable Automatic Daylight Savings Time Change.
    - b. Latched operation of zone outputs to control lighting or other devices.
    - c. Interface with most types of secondary slave clocks whether synchronous wired, wireless or electronic.
    - d. User-programmable custom slave clock correction. Output relays rated at 5 amperes shall be provided on all zone circuits as necessary.
    - e. Ability to correct and power secondary clock using same Cat5e/6 supporting intercom speakers, classroom telephone, call switch and motion detector. Secondary clocks requiring more than 15 mA shall not be acceptable.
  18. System has the ability to sync system time to the Atomic Clock Signal or the school's or district's network time server. System has the ability to offset system time (+) or (-) 15 minutes from true atomic time to accommodate bus schedules or other scheduling issues.
  19. The module provide for classroom security and call switch supervision with the following features and functions:
    - a. All field wiring to call switches connected to the system shall be capable of individual supervision for opens or shorts.
    - b. System shall be capable (future) to accept multiple alarm inputs from the main security and/or fire alarm system. Emergency tones and/or announcements can therefore be triggered, via the primary security and/or fire alarm system, to provide redundant annunciation using the classroom and corridor speakers.
- B. Interior Recess-mounted Wall/Ceiling Speakers
1. Provide premium quality 8" cone transducer speaker. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. The speaker shall have a frequency response of 65 Hz to 17 KHz with a power rating of 8 watts. Sensitivity shall be 93 dB, 1 watt, 1 meter. Voice coil shall be  $\frac{3}{4}$ " diameter with a 5-ounce magnet. When installed in ceiling, no speaker assembly weight shall be resting on any ceiling tiles.

2. The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rust-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4"x10-3/4" deep and shall be capable of accommodate the clock speaker baffle in locations designated.
  3. The surface mount clock/speaker back box shall be of 22 gauge cold-rolled steel, with baked powdered epoxy cool gray finish. Supports either vertical or horizontal mounting. The surface mount clock/speaker backbox shall be 20.18"x14.26"x2.78" deep.
  4. The baffle shall be constructed of a one-piece, 22 gauge cold-rolled steel, zinc- treated to prevent corrosion. The finish shall be white baked powdered epoxy and be virtually scratch/mar proof. The baffle perforation pattern shall be designed for wide sound dispersion and screw attachment to top of the back box.
- C. Recessed Wall Mounted Horns
1. Provide double re-entrant type horn loudspeakers with integral driver. The horn loudspeaker shall be impervious to weather and vandalism. Horn shall be constructed of heavy-duty ABS plastic. Horn loudspeaker drivers shall be rated at 15 watts with a frequency response of 480 Hz to 14 KHz. Sensitivity shall be 106 dB 1 watt, 1 meter. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. Dispersion patter shall be 180 degrees conical. The horn loudspeaker shall be constructed of treated heavy gauge aluminum, with all exposed p arts potted and sealed driver. Wiring terminal shall be fully enclosed. The speaker flange and mounting surface shall have a cork-rubber gasket. The horn loudspeakers finish shall be gray baked on enamel.
  2. The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rust-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4"x10- 3/4"x6"deep.
  3. The baffle shall be vandal proof, the faceplate constructed of 14-gauge carbon steel with a minimum tensile strength of 55,000 PSI. A lattice grid sub-plate shall deny access to the horn but be acoustically transparent for sound projection. Provide tamper proof, stainless steel mounting hardware. The baffle shall a mar/scratch baked epoxy rust inhibitive finish.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine condition, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network.
- B. Do not proceed until unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.
- B. Furnish and install all material, devices, components and equipment for a complete operational system.
- C. Impedance and Level Matching: Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.
- D. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated of specified.
- E. All housings are to be located as indicated.
- F. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

- G. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
- H. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.
- I. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.
- J. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

**3.03 FIELD QUALITY CONTROL**

- A. Manufacturer’s Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Inspection: Make observations to verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
- C. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor’s expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

**3.04 FINAL ACCEPTANCE TESTING**

- A. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.
- B. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner’s Representative establishing the “In Warranty” date. The warranty period will not commence until the Final Acceptance Test is completed.

**3.05 OCCUPANCY ADJUSTMENTS**

- A. The contractor shall provide Occupancy Adjustments in accordance with Section 1.6, paragraph 9 of these specifications. A response scenario amenable to both the owner and the contractor will be established and followed for the first year of service.

**3.06 CLEANING AND PROTECTION**

- A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked, and all cabinet keys will be turned over to the owner or designated owner’s representative.

**END OF SECTION**

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**SECTION 27 5313  
GPS (PRIMEX) WIRELESS CLOCK SYSTEM**

**PART 1 GENERAL**

**1.01 GENERAL**

- A. Middle/High School:
  - 1. Provide additions and modifications to the existing system as indicated on plans.

**1.02 SECTION INCLUDES**

- A. Clocks
  - 1. Analog (Lithium battery powered)

**1.03 RELATED SECTIONS**

- A. Division 26 – Electrical (120 volt grounded outlet required for transmitter.)

**1.04 REFERENCES**

- A. This Technical Specification and Associated Drawings

**1.05 SYSTEM DESCRIPTION**

- A. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Savings Time.
- B. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- C. The system shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
- D. The system shall incorporate a “fail-safe” design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
- E. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

**1.06 SUBMITTALS**

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.
- B. Operating License: Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license must be delivered to the Owner/End User.
- C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.
- D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.
- E. Floor plans indicating the location of system transmitter(s), approved by manufacturer, will be submitted to owner prior to installation.

**1.07 QUALITY ASSURANCE**

- A. Permits: Obtain operating license for the transmitter from the FCC.
- B. Qualifications:

1. Manufacturer: Company specializing in manufacturing commercial time system products including 4 years experience producing GPS wireless time systems.
  2. Installer: Company with documented experience in the installation of commercial time systems.
- C. Prior to installation, a site survey must be performed to determine proper transmitter placement.

#### **1.08 DELIVERY STORAGE AND HANDLING**

- A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
- B. Store equipment in finished building, unopened containers until ready for installation.

#### **1.09 PROJECT SITE CONDITIONS**

- A. Clocks shall not be installed until painting and other finish work in each room is complete.
- B. Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.

#### **1.10 SYSTEM STARTUP**

- A. At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all clocks are functioning.

#### **1.11 WARRANTY**

- A. Manufacturer will provide a 5 year warranty on GPS receiver and transmitter. All other components will have a 1 year warranty.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURER**

- A. GPS wireless clocks: Pyramid Wall Clock: Radio Freq, Arabic, Round, 13 1/4 in Overall Dia., 13 in Face Dia., Battery, Analog
- B. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- C. Other systems requiring wiring and/or conduit between master and clocks will not be accepted.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
- B. Verify that 120 volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.

#### **3.02 INSTALLATION**

- A. Analog clocks (Lithium battery): Perform the following operations with each clock:
  1. Install batteries.
  2. Set clock to correct time in accordance with manufacturer's instructions.
  3. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.
  4. Install the analog clock on the wall in the indicated location, plumb, level and tight against the wall. use suitable fasteners as approved by clock manufacturer.
- B. Wire guards: Secure to wall, using approved theft-resistant fasteners.

#### **3.03 ADJUSTING**

- A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

**3.04 CLEANING**

- A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

**3.05 DEMONSTRATION**

- A. Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.

**3.06 PROTECTION**

- A. Protect finished installation until final acceptance of the project.

**3.07 TESTING**

- A. All devices must be tested at their operational location under normal operational conditions to assure reception of signal.

**END OF SECTION**

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**SECTION 28 4600.02  
FIRE DETECTION, ALARM, AND COMMUNICATION SYSTEM**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
1. Furnish and install new, non-proprietary open source digital-protocol analog addressable fire alarm system with emergency communications, and all associated components for complete and fully functioning system.
  2. Remove abandoned fire alarm system, circuitry, and associated components in it's entirety.
  3. Existing fire alarm system to remain active until new system in completed.
  4. Tie new FACP to existing High School FACP and program where if either system goes into alarm, then the other system will also go into alarm.
  5. Current FACP Is a Simplex 4100 ES.

**1.02 REFERENCES**

- A. The fire alarm equipment and installation shall comply with the current provisions of the following standards and shall be listed for its intended purpose and be compatibility listed to ensure integrity of the complete system:
1. New York State Uniform Fire Prevention & Building Code
  2. National Fire Protection Association Standards:
    - a. NFPA 70 - National Electrical Code
    - b. NFPA 72 - National Fire Alarm Code
    - c. NFPA 90A - Installation of Air Conditioning and Ventilating Systems
    - d. NFPA 101 – Life Safety Code
    - e. NFPA 720 - Standard for the Installation of CO Detection
    - f. U.S. Department of Justice - American Disabilities Act
  3. Provide system and components listed by Underwriters Laboratories Inc. (UL) for use in fire protective signaling system under following standards as applicable:
    - a. UL 864 - UOJZ, APOU Control Units for Fire Protective Signaling Systems.
    - b. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
    - c. UL 268A - Smoke Detectors for Duct Applications.
    - d. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
    - e. UL 228 - Door Holders for Fire Protective Signaling Systems.
    - f. UL 464 - Audible Signaling Appliances.
    - g. UL 1971 - Visual Signaling Appliances.
    - h. UL1711 - Amplifiers for Fire Protection Signaling Systems
    - i. UL 38 - Manually Activated Signaling Boxes.
    - j. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
    - k. UL 1481 - Power Supplies for Fire Protective Signaling Systems.

**1.03 SYSTEM DESCRIPTION**

- A. Design Requirements
1. Provide complete non-proprietary open source, analog addressable, digital multi-processor based fire alarm control system, including (but not limited to) all control equipment, power supplies (primary and secondary), initiating devices, synchronized audible and visual notification appliances, emergency communications, amplifiers, speakers, conduit, wiring, fittings and all other accessories necessary to provide complete and operable system.
    - a. Provide all components necessary to connect and operate all building fire protection system interfaces including (but not limited to):

- 1) Carbon monoxide alarms.
  - 2) Fan shutdown operations.
  - 3) Building energy management systems for programmed fan re-start.
  - 4) Automatic door release.
  - 5) Automatic fire extinguishing systems.
  - 6) Notification of alarm to central station monitoring agency.
- b. Sequence of Operation – Fire Alarm:
- 1) Operation of fire alarm manual station or automatic activation of any fire alarm initiation device activates following system responses:
    - (a) All audible indicating appliances sound in temporal time pattern and all visual indicating appliances to flash.
    - (b) Automatic shutdown of all air moving equipment throughout building.
    - (c) Automatic release of all magnetically held open doors.
    - (d) Indication of alarm location on main fire alarm panel LCD display, and remote LCD display(s). (NOTE: EC shall coordinate system addresses with Owner prior to final programming to assure correct room numbering. Room numbering shall match door numbers upon completion of project.)
    - (e) Notification of alarm to central station monitoring agency.
    - (f) Activation of all fire protection system interfaces specified in this Section or indicated on Drawings.
- c. Sequence of Operation - Carbon Monoxide:
- 1) Automatic activation of any carbon monoxide initiation device activates following system responses:
    - (a) Alarm notification via activated detector(s)/sounder base and adjacent space sounder base. Carbon monoxide alarm shall utilize a separate and distinct audio cadence pattern than fire alarm pattern. Alarm shall operate continuously until acknowledged.
    - (b) Identify alarm condition at the FACP and remote annunciators.
    - (c) Transmit a trouble alarm signal to the remote alarm receiving station.
    - (d) Record events in the system memory.
    - (e) Record events by the system printer.

#### 1.04 PERFORMANCE REQUIREMENTS

- A. Fire Alarm System: Provide individual multiplex data address indicating building zone and room number for each manual pull station, smoke detector, heat detector, duct smoke detector, addressable monitor module and addressable control module with fire alarm control panel capable of supporting up to system total of 159 detector addresses and 159 analog addressable modules. The system shall be expandable to 1,110 analog addressable points per control panel.
- B. Fire Alarm Control System: Provides Class A, Style E (NFPA-72) analog addressable data communications circuits to provide connection of, and communication with, addressable devices.
1. Each addressable data communications circuit provides capability of communicating with up to 159 addressable devices.
  2. Each circuit; connect up to maximum 70 percent capacity to permit future additional addressable devices and capable of communicating with addressable device up to 2,500 ft. distant.
  3. Circuits support 100 percent of addressable devices in alarm or operated at same time during both primary and secondary power supply conditions.

- C. Addressable Monitor Modules - Provides individually-addressed alarm-initiating, supervisory or status monitoring circuits complying with requirements for minimum of 1 Class A, Style E (NFPA-72) supervised circuit for following non-addressable devices (NOTE: EC shall coordinate system addresses with Owner prior to final programming to assure correct room numbering.)
  - 1. Boiler Room: 1 alarm initiating circuit for all 200 deg. F fixed temperature non-addressable heat detectors located in Boiler Room.
  - 2. Kitchen: 1 alarm initiating circuit for all 200 deg. F fixed temperature non-addressable heat detectors located in Kitchen.
  - 3. Carbon Monoxide: 1 alarm initiating circuit for all carbon monoxide detectors.
- D. Addressable Control Modules: Provided with relays with at least 1 SPDT control contact to provide fire alarm system control of following remote equipment (NOTE: EC shall coordinate system addresses with Owner prior to final programming to assure correct room numbering):
  - 1. Air Moving Equipment: Provide 1 shutdown contact for each air-moving unit.
  - 2. Elevator Control Panels: Provide 2 elevator recall contacts for each elevator control panel.
  - 3. Kitchen Gas Valve: Provide 1 shutoff contact for each kitchen gas valve.
  - 4. Science Room Gas Valve: Provide 1 shutoff contact for each Science Room gas valve.
- E. Fire Alarm Control System:
  - 1. Provide each of following types of alarm sounding, indicating or communicating devices with Class B, Style Y (NFPA-72) supervised, alarm indicating appliance and/or communicating circuits:
    - a. Horn Indicating Appliance: Provide minimum 1 circuit for each floor, with no more than 20 horns connected to each circuit.
    - b. Alarm Strobe Indicating Appliance: Provide minimum of 1 strobe light circuit for each floor, with no more than 20 strobe lights to each circuit.
  - 2. Provides relays for connection to and control of associated equipment, as follows:
    - a. Central Station Agency Connections: Provide 3 SPDT contacts (system alarm condition, system supervisory off-normal condition, and system trouble condition) for connection to central station agency transmitter.
    - b. Magnetic Door Holders: Provide minimum 1 circuit for each floor, control contact for magnetic door holders.
- F. Emergency Communications System:
  - 1. The audio amplifiers shall be capable of expansion to a minimum of 384 total amps via bus connected expander modules that supervise low battery, loss off AC and loss of communication.
  - 2. The system must contain at least one amplifier and shall be expandable from 50 to 500 watts utilizing up to 3 additional amplifiers. The amplifiers shall be able to support a 4-zone splitter to distribute the audio information to different locations in the facility or facilities. The system shall have the capability of controlling up to 32 notification zones. The amplifiers must contain the capability of being remotely located through a four-wire communications circuit and a two-wire voice circuit. The system shall have the capability of adding up to 4 local operating emergency communication control consoles.
  - 3. The emergency communication system must have the capability of downloading fifteen (15) 60 second messages and utilize DSP technology for higher audio intelligibility.
  - 4. The emergency communication system shall be capable of operating at 25vrms or 70.7vrms and must be field selectable at the amplifier level. Systems that require additional modules for voltage conversion shall not be accepted.

**1.05 SUBMITTALS**

- A. Comply with requirements of SECTION 01 3000 - Administrative Requirements (and as modified below);

1. Submit all submittal documentation specified in this Section no later than 30 calendar days after Award of Contract.
  2. Obtain Architect's acceptance of submittals in accordance with General and Supplementary Conditions and SECTION 01 3000 - Administrative Requirements before ordering any components or equipment in proposed fire alarm system.
- B. Product Data: Submit manufacturer's documentation for all components of proposed fire alarm system required to demonstrate compliance with specified requirements, including (but not limited to) type, size rating, style, catalog number, manufacturer name, photograph, and catalog data sheet for each component.
- C. Shop Drawings: Submit following diagrams in both hard copy as well as computer disk format with supporting software to display diagrams on standard PC compatible computer.
1. Submit complete one-line riser diagrams showing all equipment locations and sizes, and point-by-point wiring diagram with type and number of all conductors. Indicate device identification on one-line diagram.
  2. Submit detailed drawing of Fire Control Panel(s) including all module/component locations and panel point-to-point wiring diagrams including all field circuit termination points. (NOTE: Installer shall coordinate system addresses with Owner prior to final programming to assure correct building zone and room numbering.)
  3. Submit floor plan layout of Graphic Display Panel indicating building zones, room numbers, and "You Are Here" location.
- D. Quality Control Submittals
1. Design Data
    - a. Submit calculations indicating size of standby batteries submitted for each panel and or power supply to provide minimum of 24 hours of standby power with additional 15 minutes of alarm at the end of the 24 hour period.
    - b. Submit calculations for signal circuit and power supply loading indicating amount of devices per circuit, alarm current per circuit, and alarm current per power supply output.
    - c. Submit complete list of all system points to be monitored and controlled as related to individual fire alarm control panel's initiating, signaling and control circuits.
  2. Contract Closeout Submittals: Comply with requirements of SECTION 017800, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.
    - a. Deliver 2 copies of following documentation to Architect within 15 days after date of system acceptance:
      - 1) Installation and programming manuals covering installed systems.
      - 2) Point-to-point diagrams of entire systems as installed including number of all conductors with indications of all terminations and splices. Diagram shall include system address and locations of all devices. (NOTE: Installer shall coordinate system addresses with Owner prior to final programming to assure correct building zone and room numbering.)
      - 3) Complete control panel generated and printed system sensitivity report showing all sensors with their address, associated sensitivity levels, current obscuration values, number of times device alarm verification has occurred, and current at time of acceptance.
      - 4) Full acceptance test report of inspection as provided to Architect and Fire Subcode Official as specified in "Acceptance Testing" in Field Quality Control in Part 3 below.

#### **1.06 SEQUENCING AND SCHEDULING**

- A. Do not interrupt existing fire alarm system while building is occupied. Coordinate and schedule all system interruptions with Owner's authorized representatives.

## 1.07 WARRANTY

- A. The Contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of two year from date of final acceptance by Owner or Architect. If any defects in materials or workmanship or operational failure under normal usage are experienced within warranty period, promptly correct at no expense to Owner.

## 1.08 MAINTENANCE

- A. Maintenance Service: Provide complete maintenance service for entire system for 1 year after final acceptance of system.
- B. The contractor shall make available to the Owner a maintenance contract proposal to provide a minimum of two inspections and tests per year in compliance with NFPA-72 guidelines.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Existing system and devices are connected to a Simplex 4111 ES Control panel

### 2.02 COMPONENTS

- A. System Circuitry:
  - 1. The Signaling Line Circuit (SLC) and Data Communication Bus (SBUS) shall be wired with standard NEC 760 compliant wiring. No twisted, shielded or mid capacitance wiring is required for standard installations. All FACP screw terminals shall be able to accept 14-18 AWG wire. All system wiring shall be in accordance with the requirements of NFPA 70, the National Electrical Code (NEC), and also comply with article 760 of the NEC.
    - a. Each SLC shall be capable of a wiring distance of 5,000 feet from the SLC driver module (6815) and be able to support 127 addressable module devices. The communication protocol to SLC devices must be digital. Any SLC loop device, which goes into alarm, must interrupt the polling cycle for priority response from the FACP. The FACP must respond consistently to a device that goes into alarm on an SLC in under 10 seconds. The auxiliary 6815 SLC loop module must be capable of being located up to 6000 feet from the FACP on an RS-485 bus, which is separate from the SLC bus. The SLC shall be capable of functioning in a class A or class B configuration.
  - 2. SLC loop Devices: Devices supported must include photoelectric smoke detectors, heat detectors, combination fire and CO detectors, contact monitoring modules and relay output modules. There is to be no limit to the number of any particular device type, up to the maximum of 159 detectors and 159 modules that can be connected to the SLC.
  - 3. The FACP shall support six programmable circuits that are capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits shall also be programmable as input circuits in Class A or B configurations to support dry contact or compatible two wire smoke detectors
- B. Detectors
  - 1. Combination Fixed Temperature/Rate-of-Rise Heat Detectors: Addressable combination fixed temperature/rate-of-rise heat detector including thermistor heat sensor and operating at fixed temperature and predetermined temperature rise.
    - a. Continually monitors temperature of air in surroundings to minimize thermal lag to time required to process alarm.
    - b. Integral microprocessor determines if alarm condition exists and initiates alarm based on analysis of data.
    - c. Addressable heat detector has nominal fixed temperature rating of 135 deg. F (57 deg. C) and rate of rise rating of 15 deg. F (9 deg. C)/minute.

2. Fixed Temperature Heat Detectors: Non-addressable 200 degree fixed temperature heat detector provided in all areas where rapid rise in temperature may be expected as normal operating conditions.
    - a. Detectors operate when temperature of center disk rises to rated temperature and element activates.
    - b. Detector is non-restorable and when activated, must be replaced.
    - c. Where non-addressable detector is used, provide addressable monitor module as specified.
  3. Smoke Detectors: Addressable photoelectric type with sensor having software defined sensitivity of 0.5 percent/ft to 3.0 percent/ft. and signal-to-noise ratio of 2.0 nominal.
    - a. Visual indication of alarm provided by latching LED on detector that periodically pulses to indicate power is being supplied to detector.
    - b. LED feature user-defined.
    - c. Visible alarm signal capable of being remotely annunciated.
  4. Duct Smoke Detectors: Equipped with addressable solid state ionization smoke detector heads capable of detecting visible and invisible products of combustion, capable of operating with variations in duct air velocity between 400 and 4000 fpm, and listed by Underwriters Laboratories, Inc. under current standards for duct smoke detectors to allow remote functional testing without generating smoke.
    - a. Enclosed in housing suitable for mounting to air duct, with sampling tube extending into air stream.
    - b. Each unit provided with remote mounted key operated Alarm Indicator/Test Switch.
  5. Beam Smoke Detectors: Each receiver and transmitter addressable, acting as its own system, and reporting alarm and trouble conditions to fire alarm control panel.
    - a. Operates between 18 to 32 VDC and contains electronics for automatic synchronization.
    - b. Operates in either short range of 30 to 100 ft. or long range of 100 to 300 ft.
    - c. Features automatic gain control to compensate for gradual signal deterioration from dirt accumulation on lenses.
    - d. Each unit provided with remote mounted key operated Alarm Indicator/Test Switch.
  6. Carbon Monoxide Detection:
    - a. Provide non-addressable CO detection device and equip with an addressable monitor module that shall supervise the onboard contact closure.
    - b. CO detector shall be UL 2075 listed.
    - c. Suitable for wall and/or ceiling mounting.
    - d. Shall be equipped with End of Life Alerting.
    - e. FACP Programming:
      - 1) Program FACP to annunciate a supervisory condition when CO has been detected.
      - 2) Equipment shall also be self-sounding and shall utilize the Temporal 4 signal style.
- C. Manual Pull Station: Addressable, non-coded double action type, requiring outer door to be lifted to expose actuator door. Upon pulling forward actuator door, unit locks into readily observable "alarm" position.
1. Manual station constructed of aluminum.
  2. Each manual station requires key to reset actuated station; key same as key opening Fire Alarm Control Panel.
- D. Visual Alarm Signaling Appliances: Provide synchronized strobe light units in wall mount configuration, UL listed for fire protection service and producing field selectable 30, 75, 100 candela (CD) in accordance with ADA and 15 candela in accordance with UL 1971 and providing minimum flash rate of 0.33 HZ and 3 HZ maximum.

1. Provides 0.2 seconds pulse duration with maximum duty cycle of 40 percent and time interval between initial and final points of 10 percent of maximum signal.
  2. All strobes shall be synchronized and conform to applicable provisions of Americans with Disabilities Act (ADA), UL standard 1971, NFPA 72, and ANSI A117.1 for light intensity and distribution and integrated with fire alarm system.
  3. Provide layout, design and candela ratings for common areas complying with provisions of NFPA-72 -2002.
- E. Audible Horn - Alarm Signaling Devices
1. Audible Horn Multi-Tone Electronic Signals: Offer choice of 8 nationally and internationally recognized alerting sounds with each synchronized audible horn appliance having 2 user-selective sound output levels: Standard DBA and High DBA.
    - a. Separate input terminals available and shunt wires provided to enable both tone and strobe to operate simultaneously from single output.
    - b. Audible signals UL listed for indoor use, ceiling and wall mount, under UL Test Standard 464 for Audible Signal Appliances.
- F. Supplementary Relay Controls
1. Fire alarm control unit incorporate necessary alarm activated relays as pilot control for fan shutdown, door release, etc., as specified.
  2. Shutdown of designated HVAC units through auxiliary contacts of fire alarm control panel after alarm condition initiated from any initiating device as shown on Drawings.
  3. Auxiliary relay controls provided in elevator machine room to interface elevator lobby smoke detector alarm signals with designated and alternative recall options of elevator controller. Refer to Elevator Detection Wiring Diagram on Drawings.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Verification of Conditions (by Installer): Examine conditions under which fire alarm system is to be installed in coordination with system supplier. Notify Architect / Engineer, in writing, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

#### **3.02 PREPARATION**

- A. Protection: Provide manufactured dust covers on all detectors in the proximity of active work during construction. (Loose plastic cling-wrap styled coverings shall not be permitted).

#### **3.03 INSTALLATION**

- A. Install fire alarm system in accordance with applicable provisions of NEC, NFPA-70, Article 760 - Fire Protective Signaling Systems.
1. Contractor performing fire alarm system work shall have NYCET certification or shall be a licensed fire alarm contractor. Contractor shall provide Fire Alarm Certification at time of permit application.

2. Where existing fire alarm systems are being replaced, Contractor performing fire alarm system work shall comply with the requirements of the local Fire Marshall concerning the fire alarm system shutdown plans, procedures, and fire watch plans that will be implemented for system interruptions during construction. All existing fire alarm devices shall remain active until new cabling and devices are installed. Temporary interruptions are allowed while work is being done on the system. Work shall be coordinated so that system is fully functional at the end of the workday. If system is not fully functional at end of workday, Contractor shall provide personnel for fire watch as required by local Fire Marshall. and shall be responsible for all associated costs.
  3. Provide all labor, materials, equipment and services to perform all operations required for complete installation of fire alarm system and related construction as shown on Drawings and specified in this Section.
  4. Completely check, program and adjust all new and existing equipment on each system.
  5. Label each addressable device with label indicating device's unique address. Label shall comply with Specification Section 26 0553. Labels shall be installed so that they are visible without removing device from mounting base.
- B. Wiring
1. All fire alarm cable shall be (initiating and notification circuit wiring), shall be Type FPLP plenum rated, sized in accordance with manufacturer's recommendations, regardless of environmental conditions.
  2. All FA cable located above accessible ceilings shall be bundled and tie-wrapped at 5 foot intervals and hung in saddle rings or J-hooks, supported to structure at 5 foot intervals. Cable shall not be considered properly supported by laying over top of conduits, piping, or building supports or bracing, approved saddle rings or J-hooks must be used.
  3. For wall mounted devices in finished spaces, or existing construction, where wiring cannot be concealed; all wiring shall be installed in surface metallic raceway, from device location to accessible ceiling space.
  4. Install all wiring in approved red finish EMT conduit in the following locations:
    - a. Unfinished areas (above ceilings, accessible attics, accessible crawl spaces, accessible basements, mechanical rooms, electric rooms, etc...)
    - b. Exposed, open joist spaces (storage rooms, shops, upper gymnasiums, upper stage, etc...)
    - c. Where otherwise subject to damage.
- C. Install all devices on exterior of building in weatherproof enclosures supplied by device manufacturer.
- D. In existing construction, install all interior surface mounted devices on surface mounted back boxes supplied by device manufacturer. In new construction, install all devices flush or semi-flush mounted, unless otherwise authorized by Owner.
- E. Connect alarm signaling circuits (SLC) so that signaling circuit or power supply output does not exceed 70 percent of rated capacity and install circuits with appropriately sized cable, sized per 100 percent of rated circuit capacity, in accordance with manufacturer's requirements.
- F. Install 200 deg. F. fixed temperature heat detectors in Kitchen and Boiler Room. Install 135 deg. F. fixed temperature heat detectors in areas where sudden temperature changes can be anticipated (near overhead doors, heating units, etc.).
- G. Install beam type smoke detectors, consisting of receiver and transmitter units, in direct line of sight and in accordance with spacing & placement requirements outlined in the National Fire Alarm Code, NFPA-72 2002 and its latest revisions. Contractor shall be responsible for the final coordination of all ceiling hung equipment, including, but not limited to, duct work, fixed and movable equipment, etc., to ensure complete unrestricted operation of beam detectors.

- H. Provide fan shut-down of all HVAC equipment having 1000CFM (or greater) air movement capacity. Locate relay within 36 inches of units power disconnect, ahead of all controls.
- I. Provide duct smoke detectors in the supply and return air ductwork of all HVAC systems having 2000 CFM (or greater) air movement capacity. Install the supply duct detector downstream of the air filters and ahead of any branch connections. Install the return duct detector between the air handling unit and any re-circulation or fresh air inlet connections. Provide fan shut-down relay on power home run circuits, ahead of all controls.
- J. Install all fire alarm pull stations at 48 inches AFF, to conform to ADA requirements.
  - 1. In locations where new device is replacing existing, contractor shall coordinate removal/replacement to allow re-use of existing backbox/conduits if possible.
  - 2. In existing construction all devices shall be flush mounted with circuit wiring concealed within wall.
  - 3. In locations where building construction prohibits flush-mounted installations, provide surface raceway device similar to "The Relocator" by L.E.D. Products, Wilmington, North Carolina. At such locations obtain written authorization from Owner's representative or Architect prior to providing surface raceway device.
  - 4. Provide vandal resistant lexan shield (LS) in all Gymnasiums and Industrial Technology Shops / labs or as otherwise directed.
- K. Locate audible/visible signaling devices in strict accordance with requirements of Americans with Disabilities Act (ADA).
  - 1. In locations where new device is replacing existing, contractor shall coordinate removal/replacement so that existing backbox/conduits can be re-used.
  - 2. In existing construction all devices shall be flush mounted with circuit wiring concealed within wall.
  - 3. In locations where building construction prohibits flush-mounted installations, provide surface raceway. At such locations obtain written authorization from Owner's representative or Architect prior to providing surface raceway device.
  - 4. Where combination audible/visible units used, place strobe light lens 80 inches minimum and 96 inches maximum above floor level.
  - 5. In locations where ceiling height is less than 90 inches AFF, place strobe light lens 6 inches below ceiling.
- L. In areas where detection and notification devices may be subject to physical damage, devices shall have protective wire guards as manufactured by Safety Technology International ([www.sti-usa.com](http://www.sti-usa.com)). All guards shall be listed for the fire alarm system devices and appliances protected.
- M. Locate Graphic Display Panel adjacent to each remote annunciator and FACP. Confirm quantities and locations indicated on plans.
- N. Install Magnetic Hold-Opens in collaboration with Contractor responsible for door installations.
- O. Install remote-test-switch devices associated with duct smoke detection or beam detection devices at accessible locations, (while standing at floor level). Clearly identify associated duct detector location and HVAC unit monitored on switch.
- P. Surface mount detection devices / notification appliances on FA manufacturer provided red finished surface mount box. Generic surface raceway / surface mount boxes will not be permitted.
- Q. Upon acceptance of new fire detection and alarm system, Contractor shall disconnect and remove abandoned system in it's entirety, inclusive of all circuitry, conduits, cabinets, and associated equipment.

### 3.04 FURNISH & INSTALL EXTRA MATERIALS

- A. As part of bid price, include labor and materials required to fully install and connect the following equipment. Installation shall be as directed by the Engineer and/or Owner during construction. All extra materials not used shall be turned over to the Owner at substantial completion.
- B. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed but not less than four (2) units.
- C. Notification Appliances: Furnish quantity equal to 5 percent of each type and number of units installed, but not less than two (2) of each type appliance with 50 LF notification appliance circuitry for each appliance.
- D. Detector / Sensor Heads: (inclusive of smoke detectors, heat detectors, CO detectors): Furnish quantity equal to 5 percent of each type and number of units installed but not less than two (2) (one of each type).
- E. Detector or Sensor Bases (where applicable): Furnish quantity equal to 5 percent of each type and number of units installed but not less than two (2) of each type with 200 LF FA circuitry cable each base.
- F. Duct Smoke Detectors, Enclosures, and Associated Remote Reset/Test Switch: Furnish four (4) extra with 200 LF notification FA cable each device for use during construction where directed by the Engineer and/or Field Project Representative.
- G. Fuses: Four (4) of each type installed in the system.
- H. Relays (Including Addressable Modules, Relay Modules, Control Modules and Contact Closure Modules): Furnish quantity equal to 5 percent of each type and number of units installed, but not less than three (3) of each type.

### 3.05 QUALITY CONTROL

- A. All fire alarm system equipment shall be new, unused, UL listed for its intended purpose, and be fully compatible to assure the integrity of the complete system.
- B. Acceptance Testing:
  - 1. Perform 100 percent inspection and testing of all system devices.
    - a. Provide complete panel real-time printout as documentation of device, date and time. Any acceptance test not accompanied by real-time printout requires retesting of entire system by Contractor, including both alarm activation tests and tests of supervisory circuit at each device.
    - b. Provide inspection complying with requirements of applicable NFPA standards.
    - c. Provide to Owner and Fire Subcode Official complete typed list of every initiation, signaling, control, supervisory and auxiliary device with specific information regarding system address of device, location of device, date tested, manufacturer's model number, serial number of all analog components, status of device and zone or point as related to system. Obtain from owner the owner's room names/numbers that are to be assigned to each device.
    - d. Complete NFPA 72 Record of Completion document.
  - 2. Provide complete set of battery test results for panels including:
    - a. Charger output voltage under normal conditions
    - b. Charger output current under normal conditions
    - c. Open battery voltage
    - d. Supply voltage and current under primary power failure
    - e. Supply voltage and current under primary power failure and system alarm that has activated all of panel's audible, visual and control circuits.

- f. Calculations using battery test data obtained to determine minimum battery capacity of 24 hours under normal conditions and 5-minute alarm condition.
- 3. Take voltage readings at end of line of each alarm signal circuit to insure minimum operational levels.
  - a. If voltage drop exceeds maximum of 3.4 volts from power supply to end of line under full circuit load, rewire circuits with appropriately heavier gage wire as required to comply with specified requirements.

**3.06 ADJUSTING / CLEANING**

- A. Completely clean all smoke detectors, as instructed by authorized factory representative, when system is substantially complete and accepted by Owner.

**--- END OF SECTION ---**

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**SECTION 31 0000  
EARTHWORK**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Clearing and grubbing
- B. Removal of topsoil
- C. Underground utilities
- D. Excavation
- E. Dewatering
- F. Settlement detection
- G. Placing engineering fabric
- H. Placing fill and backfill
- I. Placing fill to support structures
- J. Compaction
- K. Rough grading
- L. Subgrade surface for walks and pavement
- M. Finish grading
- N. Maintenance and restoration
- O. Disposal of excess and unstable materials
- P. Field quality control
- Q. Protection

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 31 1000 - Site Clearing
- B. Section 31 2317 - Site Trenching
- C. Section 32 1216 - Asphalt Paving
- D. Section 03 3001 - Concrete Sidewalks, Curbs and Exterior Concrete Flatwork
- E. Section 32 9230 - Athletic Field Construction
- F. Section 33 4000 - Storm Drainage Utilities

**1.03 DEFINITIONS**

- A. The following terms shall have the meanings ascribed to them in this Article, wherever they appear in this Section.
  - 1. Earth Excavation: The removal of all surface and subsurface material not classified as rock (as defined below).
  - 2. Materials which can be loosened with a pick or backhoe, frozen materials, soft laminated shale or hardpan, pavements, curbs, and similar materials shall be classified as earth excavation.
  - 3. Unclassified Earth Excavation: The excavation and disposal of all surface and subsurface materials of any description necessary to perform the work of this contract. This shall include:
    - a. All soil deposits of any description both above and below groundwater levels. These may be naturally deposited or placed by previous construction operations.

- b. Ledge rock of all quality. (Limestone, sandstone, shale, granite and similar materials in solid beds or masses in its original or stratified position which can only be removed by drilling, wedging, use of pneumatic tools or heavy ripping equipment.) Blasting operations will not be permitted to loosen any ledge rock necessary to be removed in this contract without prior written permission from the Project Designer and the Owner's Representative.
  - c. Boulders of any size.
  - d. Any materials of man-made origin.
4. Subgrade Surface: Surface upon which gravel base or topsoil is placed.
  5. Base: Select granular material which is placed immediately beneath pavement or concrete slabs.
  6. Fill: Placement of specified fill materials, in layers, above ground surface to required elevations.
  7. Backfill: Placement of specified backfill material, in layers, in excavations to required subgrade elevations.
  8. Foundation Bearing Grade: Grade/elevation at which the bottom-of-footings are constructed.
  9. Maximum Density: The dry unit weight in pounds per cubic foot of the soil at "Optimum Moisture Content" when determined by ASTM D 698 (Standard Proctor), or ASTM D 1557 (Modified Proctor).
  10. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
  11. Landscaped Areas: Areas not covered by structures, walks, roads, paving, or parking.
  12. Unauthorized Excavation: The removal of material below required elevations indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner's Representative.

#### 1.04 SUBMITTALS

- A. Comply with requirements of Section 01 3000 and as modified as below.
  1. Samples: Submit samples as follows. At the owner's discretion, take the samples in the presence of the Owner's Representative, and submit to the Owner's Representative the laboratory test results for gradation, proctors and soundness tests, when required. These tests shall be performed in accordance with ASTM standards, shall be performed and signed by a certified soils laboratory, and shall be submitted as part of the original submittal. At a minimum, the samples taken shall be of the following quantities:
    - a. General Fill: Imported Select Type 1 Granular Material: 40 - 50 lbs.
    - b. Granular Fill: Type 4 Fill: 40 - 50 lbs.
    - c. Select Granular Fill: Type 2 Subbase Course: 40 - 50 lbs.
    - d. Underdrain Filter: 40- 50 lbs, mixed to specification.
    - e. Engineering Fabric: 12" X 12" sample.
    - f. Drainage Fabric: 12" X 12" sample.
  2. Quality Control Submittals:
    - a. Base Materials: Name and location of source and the DOT Source Number. If the material is not being taken from an approved DOT Source, the results of the gradation and soundness tests performed by an ASTM certified soils laboratory will be required.
    - b. Other Aggregates: Name and location of source and soil laboratory test results.
    - c. Excavation Procedure: Submit a lay out drawing or detailed outline of intended excavation procedure for the Owner's information. This submittal will not relieve the Contractor of responsibility for the successful performance of intended excavation methods.
  3. Closeout Procedures: Comply with the requirements of Section 01 7000.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Protect filter fabric from sunlight during transportation and storage.

**1.06 PROJECT CONDITIONS**

- A. Protect existing trees and plants during performance of the Work unless otherwise indicated. Box trees and plants indicated to remain within the grading limit line with temporary fencing or solidly constructed wood barricades as required. Protect root systems from smothering. Do not store excavated material or allow vehicular traffic or parking within the branch drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.
- B. Cold Weather Requirements:
  1. Excavation: When freezing temperatures are anticipated, do not excavate to final required elevations for concrete work unless concrete can be placed immediately.
  2. Backfilling: If backfill is being placed during freezing temperatures, the backfilling operations shall be monitored by the Owner’s Representative and the following procedures shall be followed:
    - a. Frozen ground shall be removed in its entirety from beneath and five (5) feet beyond the area of fill placement.
    - b. The fill material placed shall consist of Selected Fill and shall be free of all frozen chunks that exceed four (4) inches in size. The material transported to the project site shall only consist of material excavated from below the frost depth.
    - c. At the end of the work day, the area of fill placement shall be covered with insulated blankets, or left unprotected. Other means of protection (hay, wood chips etc.) may also be used for protection provided it is approved by the Owner’s Representative.
    - d. Following work day - Remove the insulated blankets and/or strip the area of all frozen material as specified previously.
    - e. Upon establishing the subgrade elevations, protect the grades with insulated blankets or place additional material that will adequately insulate the exposed earth surface from frost. This additional fill or protective material shall be stripped just prior to pouring concrete.
- C. Land Survey Information: Field verify provided existing boundary and topographic information prior to beginning site work. Immediately report any discrepancies in boundary locations or topographic elevations affecting site construction to the Owner’s Representative. Provide profile information on existing site conditions and verification of existing topographic information to the Owner’s Representative prior to beginning site construction. Beginning site work construction without this profile information and written notification indicates Contractor’s acceptance of existing land survey data indicated on the drawings as accurate. Adjustments to the contract will not be made for discrepancies brought to the Owner’s attention after site construction has begun.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. General Fill: Subsoil excavated from project site and/or supply stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with New York State Department of Transportation gradation and material requirements for Select Type 1 as specified below:

Sieve Size	Size Opening (mm)	Percent Passing
3 inch	76.2	100
2 inch	50.8	90-100
1/4 inch	6.35	30-65
No. 40	0.425	5-40
No. 200	0.075	0-10

- B. Granular Fill: Type 4 Granular Material: Where indicated supply stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with New York State Department of Transportation gradation and material requirements specified below:

Sieve Size	Size Opening (mm)	Percent Passing
2 inch	50.8	100
1/4 inch	6.35	30-65
No. 40	0.425	5-40
No. 200	0.075	0.7

- C. Select Granular Fill Base Course Type 2 Crushed Stone: Where indicated supply stockpiled, crushed ledge rock or approved blast furnace slag. Comply with New York State Department of transportation gradation and material requirements modified below:

Sieve Size	Size opening (mm)	Percent Passing
2 inch	50.8	100
1/4 inch	6.35	25-60
No. 40	0.425	5-40
No. 200	0.075	0-7

- D. Underdrain Filter: Equal blend of No.1 and No. 2 washed crushed or uncrushed stone used as drainage fill.

1. No. 1 Coarse Aggregate:

Sieve Size	Size opening (mm)	Percent Passing
1 inch	25.4	100
1/2	12.7	90-100
1-4	6.35	0-15

2. No. 2 Coarse Aggregate:

Sieve Size	Size opening (mm)	Percent Passing
1-1/2 inch	38.1	100
1 inch	25.4	90-100
1/2 inch	12.7	0-15

- E. Pea Gravel: Comply with DOT Article 703-02 for screened gravel.

Sieve	Size opening (mm)	Percent Passing
1/2 inch	12.7	100
1/4 inch	6.35	90-100
1/8 inch	3.17	0-15
No. 200 Sieve	0.075	0-1

- F. Engineering Fabric: Fabric composed of high tenacity polypropylene yarns woven into a stable network. The fabric is to be inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids complying with the following mechanical and physical properties:

Mechanical Properties	Test Method	Unit	Minimum. Average Roll Value
Wide Width Tensile Strength	ASTM D 4595	kN/m m <sup>2</sup>	MD 17.6 (100)/CD 21.0 (120)
Grab Tensile Strength	ASTM D 4632	kN (lbs)	MD 0.9 (200)/ CD 0.9

			(200)
Grab Tensile Elongation	ASTM D 4632	%	MD 15/CD 10
Trapezoid Tear Strength	ASTM D 4533	kN (lbs)	MD 0.33 (75)/CD 0.33 (75)
Mullen Burst Strength	ASTM D 3786	kPa (psi)	2756 (400)
Puncture Strength	ASTM D 4833	kN (lbs)	0.4 (90)
Percent Open Area	COE-02215-86	%	1
Apparent Opening Size (AOS)	ASTM D 4751	mm (US Sieve)	0.300 (50)
Permittivity	ASTM D 4491	sec <sup>-1</sup>	0.05
Flow Rate	ASTM D 4491	l/min/m <sup>2</sup> (gal/min/ft <sup>2</sup> )	200 (5.0)
UV Resistance (at 500 Hours)	ASTM D 4355	% strength retained	70

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	g/m <sup>2</sup> (oz/ydm <sup>2</sup> )	136 (4.0)
Thickness	ASTM D 5199	mm (mils)	0.51 (20)
Roll Dimensions (Width X Length)	-----	m (ft)	3.8 X 132 or 5.3 X 94.2 (12.5 X 432) or (17.5 X 309)
Roll Area	-----	m <sup>2</sup> (yd <sup>2</sup> )	502 (600)
Estimated Roll Weight	-----	kg (lb)	95 (210)

1. Manufacturer: For convenience, details have been based on Mirafi 500X as manufactured by Ten Cate/Mirafi, Pendergrast, GA (Tel. #706-693-2226).

- G. Drainage Fabric: Non-woven geotextile fabric composed of polypropylene fibers formed into a stable network such that the fibers retain their relative position. The fabric is to be inert to biological degradation, resisting naturally encountered chemicals, alkalis and acids complying with the following mechanical and physical properties:

Mechanical Properties	Test Method	Unit	Minimum. Average Roll Value
Grab Tensile Strength	ASTM D 4632-91	kN (lbs)	MD 0.53 (120)/ CD 0.53 (120)
Grab Tensile Elongation	ASTM D 4632-91	%	MD 50/CD 50
Trapezoid Tear Strength	ASTM D 4533-91	kN (lbs)	MD 0.22 (50)/CD 0.22 (50)
Mullen Burst Strength	ASTM D 3786-87	kPa (psi)	1550 (225)
Puncture Strength	ASTM D 4833-00	kN (lbs)	0.3 (65)
Apparent Opening Size (AOS)	ASTM D 4751-99A	mm (US Sieve)	0.212 (70)
Permittivity	ASTM D	sec <sup>-1</sup>	1.8

	4491-99A		
Permeability	ASTM D 4491-99A	cm/sec <sup>-1</sup>	0.21
Flow Rate	ASTM D 4491-99A	l/min/m <sup>2</sup> (gal/min/ft <sup>2</sup> )	5500 (135)
UV Resistance (at 500 Hours)	ASTM D 4355-02	% strength retained	70

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	g/m <sup>2</sup> (oz/ydm <sup>2</sup> )	163 (4.8)
Thickness	ASTM D 5199	mm (mils)	1.4 (55)
Roll Dimensions (Width X Length)	-----	m (ft)	3.8 X 110 or 4.5 X 110 (12.5 X 360) or (15 X 360)
Roll Area	-----	m <sup>2</sup> (yd <sup>2</sup> )	502 (600)
Estimated Roll Weight	-----	kg (lb)	89 (197)

1. Manufacturer: For convenience, details have been based on Mirafi 140N as manufactured by Ten Cate/Mirafi, Pendergrast, GA (Tel. #706-693-2226).

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Verification of Conditions: Examine conditions under which earthwork is to be accomplished in coordination with the installer of materials and components specified in this Section and notify affected Prime Contractors, Owner's Representative and the Project Designer in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with earthwork until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
  1. When the installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to the Project Designer written confirmation from the applicable installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

#### 3.02 PREPARATION

- A. Protection
  1. Use of explosives: Do not bring explosives onto the site or use in the project without prior written permission from the Project Designer and the Owner's Representative. The Contractor remains solely responsible for the handling, storage and use of explosive materials when permitted. Use explosives in strict compliance with State, Local and OSHA regulations.
  2. Protection of Persons and Property
    - a. Barricade open excavations and post with warning lights for safety of persons. Operate warning lights during hours from dusk to dawn each day.
    - b. Protect structures, utilities, sidewalks, pavements and other facilities immediately adjacent to excavations from damage caused by settlement, lateral movement, undermining, washout and other hazards.
    - c. Take precautions and provide necessary bracing and shoring to guard against movement and settlement of existing improvements or new construction. Contractor remains entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack of adequate protection or by movement or settlement.

### **3.03 CLEARING AND GRUBBING**

- A. Clear and grub the site within the grading limit lines of trees, shrubs, brush, other prominent vegetation, debris, and obstructions except for those items indicated to remain. Completely remove stumps and roots protruding through the ground surface.
  - 1. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
  - 2. Where roots and branches of trees indicated to be saved interfere with new construction, carefully and cleanly cut them back to point of branching.
- B. Fill depressions caused by the clearing and grubbing operations in accordance with the requirements for filling and backfilling, unless further excavation is indicated.

### **3.04 REMOVAL OF TOPSOIL**

- A. Remove existing topsoil from areas within the grading limit lines where excavation or fill is required.
- B. Stockpile approved topsoil where directed until required for use. Place, grade, and shape stockpiles for proper drainage.
  - 1. Topsoil shall be tested prior to stockpiling. Stockpile only quantities of topsoil approved in writing for re-use.

### **3.05 UNDERGROUND UTILITIES**

- A. Locate existing underground utilities prior to commencing excavation work. Determine exact utility locations by hand excavated test pits. Support and protect utilities to remain in place.
- B. Do not interrupt existing utilities that are in service until temporary or new utilities are installed and operational.
- C. Utilities to remain in service shall be re-routed as shown on the Contract Drawings.
- D. Utilities abandoned beneath and five (5) feet laterally beyond a structure's proposed footprint shall be removed in their entirety. Excavations required for their removal shall be backfilled and compacted as specified herein.
- E. Unless otherwise noted in the Contract Documents, utilities extending outside the limit specified above (5 feet) may be abandoned in place provided their ends are adequately plugged as described below.
  - 1. Permanently close open ends of abandoned underground utilities exposed by excavations, which extend outside the limits of the area to be excavated.
  - 2. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs or other approved method for the type of material and size of pipe. Do not use wood plugs.
  - 3. Close open ends of concrete and masonry utilities with concrete or flow-able fill.
- F. Coordinate with other Prime Contractors or with local utility companies, as applicable, for shutoff service if lines are active.
- G. Coordinate scheduling of removal to accommodate relocation of lines when necessary.
- H. Demolish and remove or relocate additional uncharted underground utilities conflicting with construction operations as directed by the Project Designer. Measure additional removal and relocations as directed by the Project Designer and paid for by the Owner as a Change Order.

### **3.06 EXCAVATION**

- A. Excavate earth as required for the work. Remove and dispose of all materials encountered to obtain required subgrade elevations. Remove from property and legally dispose of all excess fill material.
- B. Install and maintain all erosion and sedimentation controls during all earthwork operations as specified on the Contract Drawings or as directed by local officials.

- C. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Comply with Code of Federal Regulations Title 29 - Labor, Part 1926 (OSHA).
  - 1. Trenches: Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.
- D. Stockpile excavated materials classified as suitable material where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage as approved by the Owner's Representative.
- E. Excavation for Structures: Conform to elevations, lines, and limits indicated. Excavate to a vertical tolerance of plus or minus 1 inch. Extend excavation a sufficient lateral distance to provide clearance to execute the work.
- F. Footings and Foundations: The foundation bearing grade shall be established just prior to constructing the concrete foundations when concrete is to bear on undisturbed soil.
  - 1. Stepping Footings: Cut sloping surfaces under footings, foundations, steps, and where required for other work as indicated.
- G. Slabs and Floors: Excavate to depths below bottom of concrete for addition of select granular material as indicated on the drawings:
- H. Open Ditches: Cut ditches to cross sections and grades indicated.
- I. Pavement: Excavate to subgrade surface elevation as indicated on the drawings.
- J. Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular Type 1 material without altering the required footing elevation. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavation of the same classification, unless otherwise directed by the Owner's Representative.
  - 1. Unauthorized excavations under structural work such as footings, foundation bases, and retaining walls shall be reported immediately to the Owner's Representative before any concrete or backfilling work commences.
- K. Notify the Owner's Representative upon completion of excavation operations. Do not proceed with the work until the excavation is inspected and approved.
- L. Removal of Unsuitable Material Beneath Structures and Other Improvements: Excavate encountered unsuitable materials, which extend below required elevations, to additional depth as directed by the Owner's Representative. Have cross sections taken, under the supervision of an independent Land Surveyor, to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement.
  - 1. Such additional excavation and backfilling, not due to error, fault or neglect of the Contractor and exceeding the numeric quantities indicated on the Drawings, will be paid for at a pre-negotiated or pre-established unit price by Change Order.

### **3.07 DEWATERING**

- A. Refer to subsurface logs included in the Contract Documents for information regarding subsurface conditions. The Owner shall not be liable for Change Orders resulting from the Contractor's inability to properly dewater the site.
- B. Prior to the performance of any excavations provide dewatering methods such that the groundwater table is maintained at an elevation that is beneath the excavated depth.
- C. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.

- D. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.
- E. Convey water removed from excavations, and rain water, to collecting or run-off area. Cut and maintain temporary drainage ditches and provide other necessary diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.
- F. Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.

**3.08 SETTLEMENT DETECTION**

- A. Excavating beneath the bearing grades of an existing structure: Establish a settlement detection method approved by the Owner’s Representative for structures subject to settlement from excavation, sheeting or sheet piling operations. Maintain surveillance to detect any settlement.
- B. Surcharging: Establish a settlement monitoring plan to accurately determine the settlements that have occurred and the rate that they occurred to adequately determine when settlement caused by surcharge is complete.

**3.09 PLACING ENGINEERING FABRIC**

- A. Place and overlap engineering fabric in accordance with the manufacturer’s installation instructions, unless otherwise shown.
- B. Cover tears and other damaged areas with additional engineering fabric layer extending 3 feet beyond the damage.
- C. Do not permit traffic or construction equipment directly on engineering fabric.
- D. Backfill immediately over engineering fabric. Backfill in accordance with the fabric manufacturer’s instructions and in a manner to prevent damage to the fabric.

**3.10 PLACING FILL AND BACKFILL**

- A. Surface Preparation of Fill Areas: Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Refer to Section 31 1000 - Site Clearing for additional information.
  - 1. Remove all asphalt pavement in its entirety from areas requiring the placement of fill.
  - 2. After topsoil is stripped and other improvements specifically indicated to be removed on the Contract Documents are removed, proof roll the site with a ten ton vibratory compactor (minimum six overlapping passes required) or similar equipment. Excavate soft or loose soils identified during rolling and replace with properly compacted select Type 1 granular material as directed by the Owner’s Representative or the Project Designer. Measure additional excavation and backfill as directed by the Owner’s Representative or the Project Designer and paid for by the Owner as a Change Order.
  - 3. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill materials bond with the existing surface.
- B. Excavations: Backfill as promptly as work permits, but not until completion of the following:
  - 1. Acceptance by the Owner’s Representative of construction below finish grade including, where applicable, dampproofing, waterproofing, perimeter insulation, and bearing capacity of supporting soil.
  - 2. Inspection, testing, approval, and recording locations of underground utilities.
  - 3. Removal of concrete formwork.
  - 4. Removal of temporary sheeting (or sheet piling) and backfilling of voids caused by removals.

5. Cutting off top of permanent sheeting (or sheet piling).
  6. Removal of trash and debris.
  7. Installation of permanent or temporary bracing on horizontally supported walls.
- C. Place backfill and fill materials in layers not more than 8 inches thick in loose depth unless otherwise specified. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or covered with ice.
1. Place fill and backfill against foundation walls and in confined areas (such as trenches) not easily accessible by larger compaction equipment, in maximum 6 inch thick (loose depth) layers.
  2. For large fill areas, the layer thickness may be modified by the Owner's Representative, at the Contractor's written request, if in the Owner's Representative's judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request shall include the type and specifications of compaction equipment intended for use.
- D. Prevent wedging action of backfill against structures by placing backfill uniformly around structure to approximately same elevation in each layer. Place backfill against walls of structures containing basements or crawl spaces only after the first floor structural members are in place.
- E. Under Pavements and Walks:
1. Utilize select granular fill as indicated on the construction drawings and in the applicable specification sections in the Project Manual.
- F. Landscaped Areas: Place suitable material when required to complete fill or backfill areas up to subgrade surface elevation. Do not use material containing rocks over 4 inches in diameter within the top 12 inches of suitable material.

### **3.11 ADDITIONAL REQUIREMENTS FOR PLACING FILL TO SUPPORT STRUCTURES**

- A. Place fill at the perimeter of the structure to be constructed as follows:
1. Strip the area in accordance with the requirements for Surface Preparation of Fill Areas.
  2. Compact the stripped surface to 95 percent of maximum density.
  3. Place fill in horizontal layers not exceeding 8 inches loose depth and compact layers as specified.
- B. Place fill within the perimeter of the structure to be constructed as follows:
1. Strip the area in accordance with the requirements for Surface Preparation of Fill Areas.
  2. Proof roll the stripped surface with at least 5 passes of a vibratory drum compactor having a minimum unsprung drum weight of 7 tons unless specifically indicated otherwise in the Contract Documents. Notify the Owner's Representative of the proposed date for beginning proof rolling at least 2 working days prior to commencing proof rolling.
  3. Excavate unsuitable materials (soft and unstable earth) disclosed by the proof rolling operation and replace with compacted selected Type 1 granular material.
  4. Place fill in horizontal layers not exceeding 8 inches loose depth and compact layers as specified.
- C. Obtain written approval of fill area compaction before excavating for footing.
- D. Excavate for footing width plus 1 foot on each side.
- E. Excavate 1 foot below footing elevations where bottom of footings are 2 feet or less above or 4 feet or less below original ground surface.
1. Compact footing bottom and place a 1 foot bed of select granular material. Compact select granular material in 6 inch layers.
  2. Omit excavation and select granular material below bottom of footings where footing elevations are more than 2 feet above or more than 4 feet below original ground surface.

### 3.12 COMPACTION

- A. Compact each layer of fill and backfill for the following area classifications to the percentage of maximum density specified below and at a moisture content suitable to obtain the required densities, but at not less than 3 percent drier or more than 2 percent wetter than the optimum content as determined by ASTM D 698 (Standard Proctor) or ASTM D 1557 (Modified Proctor).
  - 1. Structures (entire area within 10 feet outside perimeter): Compact subgrade and each layer of backfill or fill material to 95 percent.
  - 2. Concrete Slabs and Steps: Compact subgrade and each layer of backfill or fill material to 95 percent.
  - 3. Landscaped Areas: Compact the top 2'-0" to a maximum of 85% and compact all subgrade areas beneath the upper 2'-0" to 95%.
  - 4. Pavements and Walks: Compact subgrade and each layer of backfill or fill material to 95 percent.
  - 5. Pipes and Tunnels: Compact subgrade and each layer of backfill or fill material to 95 percent.
  - 6. Pipe Bedding: Compact subgrade and each layer of backfill or fill material to 95 percent.
- B. Compaction Equipment:
  - 1. Provide compaction equipment of suitable size and number and in satisfactory working condition to complete construction on schedule.
  - 2. Use sheepsfoot rollers, pneumatic tired rollers, vibrating tampers, or other compaction equipment capable of obtaining required density throughout the entire layer being compacted.
- C. When the existing ground surface to be compacted has a density less than that specified for the particular area classification, break up and pulverize, and moisture condition to facilitate compaction to the required percentage of maximum density.
- D. Moisture Control:
  - 1. Where fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill. Prevent ponding or other free water on surface subsequent to, and during compaction operations.
  - 2. Remove and replace, or scarify and air dry, soil that is too wet to permit compaction to specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to a value which will permit compaction to the percentage of maximum density specified.
- E. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompact and retested. If compaction cannot be achieved the material/layer shall be removed and replaced. No additional material may be placed over a compacted layer until the specified density is achieved.

### 3.13 ROUGH GRADING

- A. Interior Grading: Trim unexcavated spaces within the building to levels indicated.
  - 1. Subgrade for Interior Slabs: Compact as specified to receive fill material. Finish subgrade surface within 1 inch above or below level specified for fill required.
- B. Exterior Grading: Trim and grade area within the grading limits of the Contract Documents and excavations outside the limits, required by this Contract, to a level of 6 inches below the finish grades indicated unless otherwise specified herein or where greater depths are indicated. Provide a smooth uniform transition to adjacent areas.
  - 1. Grade areas outside building lines for each structure to drain away from structures and to prevent ponding of water. Finish surfaces free from irregular surface changes, large stones.

2. Landscaped Areas: Provide uniform subgrade surface within 1 inch of required level to receive topsoil thickness specified. Compact fill as specified to within 2 inches of subgrade surface. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil. If the top 4 inches of subgrade has become compacted before placement of topsoil, harrow or otherwise loosen rough graded surface to receive topsoil to a depth of 4 inches immediately prior to placing topsoil.

### **3.14 SUBGRADE SURFACE FOR WALKS AND PAVEMENT**

- A. Shape and grade subgrade surface as follows:
  1. Walks: Shape the surface of areas under walks to required line, grade and cross section, with the finish surface not more than ½ inch above or below the required subgrade surface elevation.
  2. Pavements: Shape the surface of areas under pavement to required line, grade and cross section, with the finish surface not more than ½ inch above or below the required subgrade surface elevation.
- B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.
- C. Thoroughly compact subgrade surface for walks and pavement by mechanical rolling, tamping, or with vibratory equipment as approved to the density specified.
- D. Shoulders: Place shoulders along edges of filled subgrades to prevent lateral movement. Construct shoulders of specified fill material, placed in such quantity to compact to thickness of each subgrade course layer. Compact and roll at least a 1'-0" wide additional layer of each subgrade course.

### **3.15 FINISH GRADING**

- A. Uniformly grade rough graded areas within the grading limits to finish grade elevations indicated.
- B. Grade and compact to smooth finished surface within tolerances specified, and to uniform levels or slopes between points where finish elevations are indicated or between such points and existing finished grade.
- C. Grade areas adjacent to building lines so as to drain away from structures and to prevent ponding.
- D. Finish surfaces free from irregular surface changes, and as follows:
  1. Grassed Areas: Finish areas to receive topsoil to within 1 inch above or below the required subgrade surface elevations.
  2. Walks: Place and compact base material as specified. Shape surface of areas under walks to required line, grade and cross section, with the finish surface not more than ½ inch above or below the required subbase elevation.
  3. Pavements: Place and compact base material as specified. Shape surface of areas under pavement to required line, grade and cross section, with the finish surface not more than ½ inch above or below the required subbase elevation.
  4. Building Slabs: Grade base material smooth and even, free of voids, compacted as specified, and to required subbase elevation. Finish final grades within a tolerance of ¼ inch when tested with a 10 foot straightedge.
  5. Surfaces To Receive Vapor Barrier: Provide smooth surfaces graded, tamped and/or rolled, entirely free of obstructions or protruding objects.
- E. Spread topsoil directly upon prepared subgrade surface to a depth measuring a minimum of 6 inches after natural settlement of the topsoil has occurred in areas to be seeded or to receive sod unless specifically indicated otherwise within the Contract Documents. Place to greater depth when necessary to adjust grades to required elevations.
  1. Only approved existing topsoil within the grading limits may be used. Provide additional topsoil from outside sources as required.

- F. Finish topsoil surface free of depressions which will trap water, free of stones over ½ inch in any dimension, and free of debris.

**3.16 MAINTENANCE AND RESTORATION**

- A. Restore grades to indicated levels where settlement or damage due to performance of the work has occurred. Correct conditions contributing to settlement. Remove and replace improperly placed or poorly compacted fill materials.
- B. Restore pavements, walks, curbs, lawns, and other exterior surfaces damaged during performance of the work to match the appearance and performance of existing corresponding surfaces as closely as practicable.
- C. Topsoil and seed damaged lawn areas inside and outside the indicated grading limits. Water as required until lawn areas are accepted by the Owner's Representative.

**3.17 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS**

- A. Remove from the work site and dispose of excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements.
- B. If acceptable to the Owner's Representative, transport excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements, to spoil areas on the project site designated by the Owner's Representative, and dispose of such materials as directed.
- C. Transport excess topsoil to areas on the project site designated by the Owner's Representative. Smooth grade deposited topsoil.

**3.18 FIELD QUALITY CONTROL**

- A. Tests: The Owner may provide soil testing and inspection services during earthwork operations. The Owner reserves the right to test and approve all subgrades and fill layers before construction proceeds.
  - 1. Compaction Testing: Provide the Owner's Representative adequate notice for all phases of filling and backfilling operations. Compaction testing will be performed by the Owner's Testing Agency to ascertain the compacted density of the fill and backfill materials. Compaction testing will be performed on certain layers of the fill and backfill as determined by the Owner's Representative and the Testing Agency. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompact and retested. No additional material may be placed over a compacted layer until the specified density is achieved.
  - 2. Tests of subgrades and fill layers may, at the Owner's option, include:
    - a. Observation of proof rolling procedures.
    - b. Observation and or inspection of unsuitable soil material.
    - c. Footing subgrades, for each strata of soil for which footings will be placed, at least one plate bearing test and field density test may be conducted if the subgrade is non-cohesive, or unconfined compression test may be conducted if the subgrade is cohesive, to verify design bearing capacities shown on the drawings. Subsequent verification and approval of each footing subgrade may be based on visual comparison of each subgrade with tested strata when acceptable to the Project Designer.
    - d. Paved areas and building subgrade areas, at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but not less than three tests may be made. In addition, in each compacted fill layer, at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but not less than three tests may be made.
    - e. Foundation wall backfill, field density tests at locations and elevations as directed may be made, with at least one test made for every 50 feet of wall.

- f. Fill under footings, in each compacted fill layer; one compaction test for every 30 LF of wall may be taken. One compaction test may be made under each individual footing.
  3. If in the opinion of the Project Designer and based on reports of the testing service, completed subgrades or fills are below the specified density, provide additional compaction and testing at no additional expense to the Owner.

**3.19 PROTECTION**

- A. Protect graded areas from traffic and erosion and keep them free of trash and debris.
- B. Repair and re-establish grades and seeding in settled and rutted areas to specified tolerances.

**END OF SECTION**

**SECTION 31 1000  
SITE CLEARING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 1000 - Summary: Sequencing and staging requirements.
- B. Section 01 5000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 01 5713 - Erosion and Sediment Control.

**1.03 SUBMITTALS**

- A. See Section 01 3000 for submittal procedures.
- B. Site Plan: Showing:
  - 1. Areas for temporary construction and field offices.

**1.04 QUALITY ASSURANCE**

- A. Clearing Firm: Company specializing in the type of work required.
  - 1. Minimum of 5 years of documented experience.

**PART 2 PRODUCTS -- NOT USED**

**PART 3 EXECUTION**

**3.01 SITE CLEARING**

- A. Comply with other requirements specified in Section 01 7000.
- B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

**3.02 EXISTING UTILITIES AND BUILT ELEMENTS**

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.

**3.03 VEGETATION**

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
- B. Do not remove or damage vegetation beyond the limits indicated on drawings.
- C. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
  - 1. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
  - 2. Around other vegetation to remain within vegetation removal limits.
- D. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
  - 1. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.

2. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
  3. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.
- E. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

**3.04 DEBRIS**

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

**END OF SECTION**

**SECTION 31 2317  
SITE TRENCHING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Trench excavation, backfill and compaction of underground piping and underdrainage.

**1.02 RELATED SECTIONS**

- A. Section 31 0000 - Earthwork
- B. Section 33 1416 - Site Water Utility Distribution Piping
- C. Division 33 4000 - Storm Drainage Utilities

**1.03 SUBMITTALS**

- A. Comply with the requirements of Section 01 3000 and as modified below.
- B. Backfill Product Data: Submit test reports for each type of gravel and/or stone specified for backfill naming the source of each material. Submit evidence that each backfill material complies with Department of Transportation standard specifications for the materials specified.
- C. Quality Control Submittals
  - 1. Experience Listing: Submit a list of completed projects similar to this project, including owner's contact information and telephone number for each project.
- D. Closeout Procedures: Comply with the requirements of Section 01 7000.

**1.04 QUALITY ASSURANCE**

- A. Regulatory Requirements: Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

**1.05 PROJECT CONDITIONS**

- A. Field Measurements: Establish and maintain required lines and elevations for grade control.

**1.06 SEQUENCING AND SCHEDULING**

- A. Proceed with and complete trenching operations as rapidly as portions of the site become available, working within seasonal limitations for the work required.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Excavated Material: Utilize on-site excavated materials consisting of loam, clay, sand, gravel or other material suitable for backfilling as approved by the Project Designer when the type of backfill material is not indicated on the Contract Documents.
- B. Sand: Natural bank sand complying with the following gradation requirements:
  - 1. 100% passing the ¾" sieve
  - 2. Less than 5% passing the Number 200 sieve.
- C. Granular Fill and Select Granular Fill: Type 1 or Tpe 2 Fill. Refer to 31 0000 - Earthwork.
- D. Pipe Bedding Material: Unless otherside indication on drawings, provide a mixture of 50% No. 1 and 50% No. 2 stone complying with the following New York State Department of Transportation Standard Specifications:
  - 1. No. 1 Stone Gradation Requirements

Sieve	Percent Passing	
Sieve Size	Size opening (mm)	
1 inch	25.4	100
1/2 inch	12.70	90-100

1/4 inch	6.35	0-15
No. 200	0.075	0-1

2. No. 2 Stone Gradation Requirements

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1 ½ inch	38.1	100
1 inch	25.4	90-100
1/2 inch	12.7	30-65
No. 200	0.075	0-10

**PART 3 EXECUTION**

**3.01 EXAMINATION**

- A. Installer Verification of Conditions: Examine conditions under which trenching operations are to occur with the materials and components specified in this section. Affected Prime Contractors, the Owner’s Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
  - 1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

**3.02 EXCAVATION**

- A. Excavate trenches to line and depth as indicated on the Contract Documents. Provide consistent, uniform support for the bottom quadrant of each section of piping, fittings and associated materials.
  - 1. Excavate no more than length of trench that can receive infrastructure installation and backfill.
  - 2. Brace and drain trenches as required. Accumulations of groundwater or storm runoff shall be immediately discharged by dewatering pumps to siltation basins or protected channels, drains or storms sewers.
  - 3. Provide adequate trench width to permit successful laying and joining of pipe, proper placement of backfill and clearance of at least 8” on either side of the pipe barrel.
  - 4. Prepare the finish grade of the trench bottom with hand tools. Where elevations are not shown on the Contract Documents, excavate the trench to place a minimum of 18” of fill above the top of the pipe. Provide “bell holes” at each pipe joint for proper joining to eliminate point bearing. Stones of 2” or greater in any dimension or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.
  - 5. Where trench excavation is carried below the specified elevation as a result of Contractor error or negligence, backfill the trench with Select Type 1 Granular Material and compact to required densities at no cost to the Owner.
  - 6. When trenching is required within the dripline of trees, tunnel under or around roots by hand digging. Do not cut tap roots or main lateral roots.
- B. Excavated Materials
  - 1. Materials satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench sufficient to avoid overloading and to prevent slides and cave-ins.
  - 2. Adequate drainage shall be provided for the stockpiles and surrounding areas by means of ditches, dikes and other approved methods.

3. Stockpiles shall be protected from contamination with unsatisfactory excavated material or other material that destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles and any material becomes unsatisfactory as a result, such material shall be removed and replaced with satisfactory on site or imported materials from approved sources at no additional cost to the Owner.
4. Excavated material not required or not satisfactory for backfill shall be removed from the site.

### **3.03 BACKFILLING**

- A. Trench Backfill: Trenches shall be backfilled to grade upon completion of required testing work.
- B. Bedding and Initial Backfill: Bedding shall be of the type and thickness as indicated on the Contract Documents or as recommended by the pipe manufacturer.
  1. Initial backfill material shall be placed in layers of a maximum of 6" loose thickness and compacted with approved tampers to the density of the adjacent in-situ soil, and to a height of at least one foot above the utility pipe, conduit or other infrastructure item. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe.
  2. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.
- C. Final Backfill: The remainder of the trench shall be backfilled with satisfactory material removed from the trench. Backfill material shall be deposited and compacted as follows:
  1. Under building slabs, roads, walks, parking lots and other structural areas, backfill shall be deposited in maximum 8" loose thickness layers and compacted to 95% maximum dry density at +/-2% of optimum moisture content.
  2. Under general landscape and natural turf playfield areas, backfill shall be deposited in maximum 12" loose thickness layers and compacted to 95% maximum dry density at +/-2% of optimum moisture content.

### **3.04 FIELD QUALITY CONTROL**

- A. Testing
  1. The Owner may provide soil testing and inspection services during the backfill of trenches as outlined in Project Manual Section 01 4000 - Quality Requirements.
  2. Prime Contractors shall employ the services of an independent testing agent to observe and test backfill operations performed by other Prime Contractors that may affect their work. An independent testing laboratory shall certify that the backfill is suitable for finish construction to be installed over trenches.
  3. Prime Contractors shall submit copies of testing laboratory reports to the Owner's Representative and the Project Designer for information only.
  4. The General Work and Site Work Prime Contractors shall accept in writing any trench backfill and compaction by other prime contractors before installing the remaining finish construction over trench work.

**END OF SECTION**

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**SECTION 32 1216  
ASPHALT PAVING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Aggregate base for asphalt paving
- B. Asphalt paving installation over aggregate base
- C. Installation of asphalt topcourse over existing paving
- D. Joining new asphalt pavement to adjacent construction
- E. Field quality control

**1.02 RELATED SECTIONS**

- A. Section 31 0000 - Earthwork

**1.03 SUBMITTALS**

- A. Comply with the requirements of Section 01 3000 and as modified below.
- B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.
- C. Job Mix Formulas: Submit job mix formulas for asphalt paving indicating compliance with the requirements of each asphalt type specified including the name and location of the supplier.
- D. Quality Control Submittals
  - 1. Certificates: Submit one copy of all permits obtained from local regulatory agencies and the New York State Department of Transportation.
  - 2. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the requirements specified below in the "Quality Assurance" section of this specification.
  - 3. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable requirements specified in the "Quality Assurance" section of this specification.
- E. Closeout Procedures: Comply with the requirements of Section 01 7800.

**1.04 QUALITY ASSURANCE**

- A. Asphalt Producer Qualifications: Use only materials furnished by bulk asphalt producer regularly engaged in the production of hot-mix, hot laid asphalt.
- B. Regulatory Requirements
  - 1. Conform to the requirements of local regulatory agencies, or if applicable, the New York State Department of Transportation, which ever is more stringent for methods and materials in work areas subject to applicable agency's review and approval. Provide materials complying with referenced New York State Department of Transportation Standard Specifications where indicated.
  - 2. Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

**1.05 PROJECT CONDITIONS**

- A. Environmental Requirements:

1. Do not apply tack coats when ambient temperature is below 50 degrees F., and when the temperature has not been above 35 degrees for 12 hours immediately prior to the application. Do not apply a tack coat when an asphalt base is wet or contains an excess of moisture.
2. Do not construct asphalt surface courses when the atmospheric temperature is below 40 degrees F., and when base material is not dry. Asphalt may only be placed when air temperatures are a minimum of 40 degrees F. and rising.

B. Field Measurements: Establish and maintain required lines and elevations for grade control.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Aggregate Base: Comply with the New York State Department of Transportation Standard Specification, Section 304, Paragraph 304-2, as modified in Section 31 0000 - Earthwork.
1. Foundation Course (Course of fill below the specified stone base course): Select Type 1 granular fill. On site material may be acceptable as fill under the gravel base portion of the asphalt pavement profile should the on site material be deemed acceptable by the Owner's Testing Agency or the Project Designer.
  2. Base Course: Type 2 crushed stone as modified in Section 31 0000 - Earthwork unless specifically noted otherwise on the Contract Documents.
- B. Asphalt Pavement: Paving materials shall comply with the New York State Department of Transportation Standard Specification. Section 400 for the materials indicated.
1. Binder Course: Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Section 401 and 403 for Asphalt - Type 3 Binder.

Sieve Size	Sieve Size (mm)	General Limits	Job Limit Tol. %
1 1/2"	37.5	100	-
1"	25.0	95 – 100	-
1/2"	12.5	70 – 90	+/-6
1/4"	6.3	48 – 74	+/-7
No. 6 Sieve	3.2	32 – 62	+/-7
No. 20 Sieve	.850	15 – 39	+/-7
No. 40 Sieve	.425	8 – 27	+/-7
No. 80 Sieve	.180	4 – 16	+/-4
No. 200 Sieve	.075	2 – 8	+/-2

- a. The PGB content shall be 4.5 - 6.5%, +/-0.4%.
  - b. The mixing and placement temperature range shall be 120 - 165 degrees C.
2. Topcourse: Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Section 401 and 403 for Asphalt - Type 7 Topcourse.

Sieve Size	Sieve Size (mm)	General Limits	Job Limit Tol. %
1/2"	12.5	100	-
1/4"	6.3	90 - 100	-
No. 6 Sieve	3.2	45–70	+/-6
No. 20 Sieve	.850	15 –40	+/-7
No. 40 Sieve	.425	8 – 27	+/-7
No. 80 Sieve	.180	4 – 16	+/-4
No. 200 Sieve	.075	2 – 6	+/-2

- a. The PGB content shall be 5.4 - 8.0%.

- b. The mixing and placement temperature range shall be 120 - 165 degrees C.
- C. Coatings: Comply with the New York State Department of Transportation Standard Specification, Section 702 for material designations indicated.
  - 1. Tack Coat: Emulsified asphalt, slow setting type, New York State Department of Transportation designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).
  - 2. Asphalt Cement Filler: New York State Department of Transportation Designation 702-05.

## **2.02 EQUIPMENT**

- A. Paving Equipment: Spreading, self propelled asphalt paving machines capable of maintaining the line, grade and minimum surface thickness specified. Spreader boxes may be used in areas where specifically approved by the Project Designer.
- B. Compacting Equipment: Self-propelled tandem roller with a minimum 10 ton weight. Hand held vibrator compactor may be used in areas not accessible to rollers when specifically approved by the Project Designer.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Installer Verification of Conditions: Examine conditions under which pavement is to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
  - 1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

### **3.02 PREPARATION**

- A. Final Preparation of Subgrades: Upon completion of preparation of subgrades as specified in Section 31 0000, thoroughly scarify the entire area to be paved and compact by rolling to smooth, hard, even surface. Finish to required grades with allowance for pavement courses above.

### **3.03 INSTALLATION**

- A. Aggregate Base Course: Comply with the requirements of the New York State Department of Transportation Standard Specification, Section 304-3, for aggregate gradations specified, unless otherwise indicated.
  - 1. Foundation Course: Place foundation course in maximum 6" layers to the thickness indicated. Compact the material with a 10 ton roller with the material at optimum moisture content for maximum compaction.
  - 2. Base Course: Completely fill voids with grits and roll with a 10 ton roller, eliminating movement of the material ahead of the roller. After rolling, verify grading with a minimum ten foot long straight edge. Satisfactorily eliminate any depression over 1/4" deep. Obtain approval of base prior to installing asphalt courses above
- B. Asphalt Paving: Pave finished surface free from depressions that may collect water. The Contractor shall remove any depressions at their own expense over 1/8" deep when tested with a six foot straight edge without evidence of patching.
  - 1. Pave over aggregate base in two courses, topcourse over binder course. Comply with the New York State Department of Transportation Standard Specification, paragraph 401-3 and paragraph 403-3 for asphalt types specified.
- C. Installation of Topcourse over Existing Paving

1. Surface Preparation: Condition existing paving in accordance with the New York State Department of Transportation Standard Specification, Section 633, prior to applying tack coat.
    - a. Tack Coat: Spray tack coat to the surface of the existing paving in accordance with the New York State Department of Transportation Standard Specification, paragraph 407-3. Apply tack coat ahead of paving equipment to allow for proper "breaking" of the material prior to the application of the new asphalt topcourse. Spray only the amount of tack coat that can be paved over in one day.
  2. Paving Topcourse: Pave topcourse graded to existing drainage basins. The thickness of the topcourse may vary to 3" to provide a smooth, evenly graded surface, but shall never be less than minimum thicknesses stated on plans. Topcourse paving shall comply with the New York State Department of Transportation Standard Specification, paragraph 401-3 and paragraph 403-3 for the asphalt type specified.
- D. Joining New Asphalt Pavement to Adjacent Construction
1. Carefully construct joints between old and new pavements, or between successive days work to ensure continuous bond between adjoining paving. Construct joints with the same texture, density and smoothness as adjacent sections of asphalt courses. Clean sand, dirt and other deleterious material from contact surfaces and apply tack coat.
  2. Offset traverse joints a minimum of 24" between succeeding courses. Cut back pavement to the edge of previously placed courses to expose an even, vertical surface for the full course thickness.
  3. Offset longitudinal joints a minimum of 6" between succeeding courses. When edges of longitudinal joints are irregular, honeycombed or inadequately compacted, cut back all unsatisfactory sections to expose an even, vertical surface for the full course thickness.
  4. In horizontal joints between the binder and the topcourse, clean all contact surfaces and spray a tack coat prior to the installation of the topcourse if the binder has been in place for longer than seven days or if the pavement is determined to be excessively dirty by the Project Designer.
  5. Seal joints with the application of asphalt cement filler, a minimum of 2" to each side of the joint.

### **3.04 FIELD QUALITY CONTROL**

- A. Flood Tests: Perform a flood test in the presence of the Owner's Representative or the Project Designer utilizing a water tank truck. If a depression ponding water more than 1/8" in depth is found, provide corrective measures to provide proper drainage.

**END OF SECTION**

**SECTION 32 1825  
INFIELD SKINNED AREA**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Construction of clay mix surfacing using approved, imported clay mixes blended with water absorbing additives as indicated on the Contract Documents.

**1.02 RELATED SECTIONS**

- A. Section 31 0000 - Earthwork
- B. Section 32 9230 - Athletic Field Construction

**1.03 SUBMITTALS**

- A. Comply with the requirements of Section 01 3000 and as modified below.
- B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.
- C. Quality Control Submittals
  - 1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the "Qualifications" requirements specified below in the "Quality Assurance" section of this specification.
  - 2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified in the "Quality Assurance" section of this specification.
- D. Closeout Procedures: Comply with the requirements of Section 01 7800.

**1.04 QUALITY ASSURANCE**

- A. Qualifications: The person's installing the work and their direct supervisor shall be personally experienced in the construction playfield areas. On site supervisory personnel shall have been employed by the company engaged in the installation for a minimum of five years. All other individuals on the installation crew must have a minimum of six months experience in the playfield contracting industry.
- B. Regulatory Requirements: Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

**1.05 PROJECT CONDITIONS**

- A. Field Measurements: Establish and maintain required lines and elevations for grade control.

**1.06 SEQUENCING AND SCHEDULING**

- A. Proceed with and complete infield construction as rapidly as portions of the site become available, working within seasonal limitations for the work required.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. For convenience purposes specifications have been based on Mar-Co Clay Products, Inc., Bright, Ontario, Canada (Tel # 800-950-2555).
  - 1. Equivalents include Premium Diamond-Tex Products, 74 Kurtz Road, Denver, PA 17517 (Tel#800-823-7866)
- B. Standard Infill Clay Mix: Engineered blend of baked clay, sand, and virgin clay below 3/16" in size. For convenience, specifications have been based on "Infield Clay 20 Series Standard" by Mar-Co Clay Products, Inc., Bright, Ontario, Canada (Tel # 800-950-2555)..

1. Color: Orange-Red.
2. Weight: Approximately 2,300 pounds per cubic yard.
3. Particle Size Analysis: 65-75% sand, 10-20% silt, and 10-20% clay.
4. Sieve Analysis: Complying with the following:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
No. 4	4.76	95-100
No. 7	2.83	65-75
No. 20	0.84	55-65
No. 60	0.25	50-60
No. 100	0.15	40-50
No. 200	0.075	35-45

- C. Mound Clay Mix: Crushed and screened, virgin, raw clay below 1/8" in size. For convenience, specifications have been based on "Mound Sport Clay" by Mar-Co Clay Products, Inc., Bright, Ontario, Canada (Tel # 800-950-2555).

1. Color: Brownish-red.
2. Weight: Approximately 2,500 pounds per cubic yard.
3. Particle Size Analysis: 25-35% sand, 35-45% silt, and 35-45% clay.
4. Sieve Analysis: Complying with the following:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
No. 4	4.76	100
No. 7	2.83	90-100
No. 20	0.84	80-90
No. 60	0.25	70-80
No. 100	0.15	65-75
No. 200	0.075	60-70

- D. Clay Bricks: Provide clay bricks of same material as mound clay and provided by the same manufacturer.
- E. Warning Track: Engineered blend of sand, silt and clay below 3/16" in size with a soft texture and very high drainage. For convenience, product is based on "Warning Track Surfacers". Color: Red.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Installer Verification of Conditions: Examine conditions under which baseball and softball fields are to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

### **3.02 PREPARATION**

- A. Upon completion of playfield rough grading, trenching and drainage work, completely scarify the subsurface thoroughly to a depth of at least 2 inches.

### **3.03 INSTALLATION**

- A. Place 6" of clay mixes unless specifically indicated otherwise on the Contract Documents.
- B. Install mound clay mix in the pitcher's areas of the infields as detailed on the Drawings.
- C. Moisten and compact all clay mix areas to 85% of maximum density by mechanically dragging and rolling to the spot elevations indicated on the Drawings.
- D. Regrade high areas or topdress low areas with additional mix materials as required to eliminate bumps, ridges, or depressions to allow for positive drainage off of clay areas.
- E. Install clay bricks as detailed on the plans, or as otherwise recommended by the manufacturer.

### **3.04 ADJUSTING AND CLEANING**

- A. Repairs and Protection.
  - 1. Repair defective areas as directed by the Project Designer.
  - 2. Protect areas from damage until acceptance of playfield construction.

**END OF SECTION**

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**SECTION 32 3113  
CHAIN LINK FENCES AND GATES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Excavation for fence post bases
- B. Concrete anchorage for posts
- C. Installation of chain link fences
- D. Installation of chain link gates

**1.02 RELATED SECTIONS**

- A. Section 32 1216 - Asphalt Paving
- B. Section 32 9230 - Athletic Field Construction

**1.03 REFERENCES**

- A. Comply with ASTM A 53 for requirements of Schedule 40 piping.

**1.04 DEFINITIONS**

- A. Height of Fence: Distance measured from the top of the concrete footing to the top of the fabric.

**1.05 SUBMITTALS**

- A. Comply with the requirements of Section 01 3000 and as modified below.
- B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.
- C. Shop Drawings: Complete detailed drawings for each height and style of fence and gate required. Include separate schedule for each, listing all materials required and technical data such as size, weight and finish to ensure conformance to the specifications.
- D. Quality Control Submittals
  - 1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the "Qualifications" requirements specified below in the "Quality Assurance" section of this specification.
  - 2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified in the "Quality Assurance" section of this specification.
- E. Closeout Procedures: Comply with the requirements of Section 01 7800.

**1.06 QUALITY ASSURANCE**

- A. Comply with the standards of the Chain Link Fence manufacturer's Institute, including (unless otherwise indicated):
  - 1. Specification for Metallic Coated Steel Chain Link Fence Fabric
  - 2. Industrial Steel Specification for Fence Rails, Posts, Gates and Accessories
  - 3. ASTM F-567 - Standard Practice for Installation of Chain Link Fence for installation unless otherwise indicated on the Contract Documents.
- B. Qualifications
  - 1. Provide metal fences and gates as a complete unit produced by a single manufacturer, including necessary erection accessories, fitting and fasteners. Products shall be provided by a company specializing in commercial quality chain link fencing with at least five years experience.

- C. Regulatory Requirements
  - 1. Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

### 1.07 PROJECT CONDITIONS

- A. Field Measurements: Establish and maintain required lines and elevations for grade control.

### 1.08 SEQUENCING AND SCHEDULING

- A. Proceed with and complete chain link fence and gate installation as rapidly as portions of the site become available, working within seasonal limitations for the work required.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Framework Standards
  - 1. Steel Pipe: Cold rolled steel pipe meeting the requirements of ASTM F 1043 with a minimum yield strength of 50,000 psi.
  - 2. Interior Coating: In line applied zinc rich coating with zinc powder loading of a minimum 90% by weight applied after fabrication conforming to ASTM B 6 high grade and Special High Grade Zinc.
  - 3. Exterior Coatings
    - a. Base Coat: Minimum .9 ounces zinc per square foot.
    - b. Intermediate Coat: Minimum 15 microgram chromate conversion per square inch.
    - c. Top Coat: Minimum 0.3 mil cross link polyurethane acrylic exterior coating.
    - d. PVC exterior coating: Fusion bonded polyvinyl chloride similar to Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan. Color to be black unless specifically noted otherwise on the Contract Documents.
  - 4. Size of Pipe: As indicated.
  - 5. Similar to SS-40 Pipe with Flo-Coat by Allied Tube and Conduit Corporation, Harvey, Illinois.
- B. Framework and Footings for Fences Up To 8'-0" High
  - 1. End Posts, Corner Posts and Pull Posts.
    - a. Pipe: 3.00" O.D.
    - b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
    - c. Footing Size: 12" O.D. by 5'-0" deep.
  - 2. Line Posts
    - a. Pipe: 2.50" O.D.
    - b. Space line posts at a maximum of 10 feet on center unless specifically noted otherwise on the contract documents.
    - c. Footing Size: 12" O.D. by 5'-0" deep.
- C. Framework and Footings for Fences 12'-0" High
  - 1. End Posts, Corner Posts and Pull Posts.
    - a. Pipe: 4.00" O.D.
    - b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
    - c. Footing Size: 24" O.D. by 5'-0" deep.
  - 2. Line Posts
    - a. Pipe: 4.00" O.D.
    - b. 8' O.C. for tennis and basketball court fences.

- c. Footing Size: 24" O.D. by 5'-0" deep.
- D. Framework and Footings for Fences Over 12'-0" High
  - 1. End Posts, Corner Posts and Pull Posts.
    - a. Pipe: 4.00" O.D. unless specifically noted otherwise on the Contract Documents.
    - b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
    - c. Footing Size: 24" O.D. by 6'-0" deep.
  - 2. Line Posts
    - a. Pipe: 4.00" O.D.
    - b. Space line posts at a maximum of 10 feet on center unless specifically noted otherwise on the contract documents.
    - c. Footing Size: 24" O.D. by 6'-0" deep.
- E. Post Brace: Provide manufacturer's standard adjustable brace at gate posts and at both sides of corner and pull posts, with a horizontal brace located at the mid-height of the fabric.
  - 1. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.
- F. Top, Intermediate, and Bottom Rails: 1.66" O.D. pipe, weighing 1.84 pounds per linear foot. Install rails in the manufacturer's longest lengths utilizing expansion couplings, approximately 6" long at each joint. Provide means for attaching the top rail securely to each gate post, corner post, pull post and end post.
  - 1. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.
- G. Swing Gate Posts
  - 1. Single leaf of gate up to 6' wide and less than 10' in height: 2.875" O.D. pipe, 5.79 pounds per linear foot.
- H. Swing Gate Framework
  - 1. 2.50" O.D. pipe, 2.72 pounds per linear foot.
  - 2. Assemble gate frames by welding. Install mid-height horizontal rails on gates over 10'-0" in height. When the width of a gate leaf exceeds 10'-0", install mid-distance vertical bracing of the same size and weight as frame members. When either horizontal or vertical bracing is not required, provide truss rods as cross bracing to prevent sag or twist.
- I. Swing Gate Hardware
  - 1. Hinges: Non-lift type, offset to permit 180 degree swing and of a suitable size and weight to support the gate. Provide 1½ pair of hinges for each leaf over 6' high.
  - 2. Latch: Forked type for single gates 10 feet wide or less. Drop bar type with keeper for double gates and single gates over 10 feet wide complete with flush plate set in concrete. Drop bar length shall be 2/3 the height of the gate. A padlock eye shall be an integral part of the latch construction.
  - 3. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.
- J. Chain Link Fabric
  - 1. Aluminum Coated Fabric: Unless otherwise specified, provide 2" mesh, 9 gauge steel wires complying with ASTM A-491, with one piece fabric widths for fencing up to 12 feet high. Fabric finish to be not less than 0.40 ounces of aluminum coating per square foot of wire surface for 6 through 10 gauge fabric and not less than 0.35 ounces of aluminum coating per square foot of wire surface for 11 through 14 gauge wire fabric in accordance with ASTM A-491.
    - a. Softball and Baseball Backstops: 9 gauge, 2" mesh fabric roof system with 6 gauge, 2" mesh wire back and sides.

2. PVC Coated Fabric: Unless otherwise specified, provide 2" mesh, 9 gauge steel wires, with one piece fabric widths for fencing up to 12 feet high. The PVC coating is to be fused and adhered to galvanized wire in accordance with Federal Specification RR-F-191 H/ID, ASTM F-668 Class 2B, and ASTM F934. Coating thickness to be 7 mils.
    - a. Manufacturer: Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan or similar.
    - b. Color to be black unless specifically noted otherwise on the Contract Documents.
  3. Selvages: Top and bottom selvages to be knuckled unless specifically noted otherwise on the Contract Documents.
    - a. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.
- K. Post Caps:
1. Weather tight closure cap, one cap per post.
  2. Furnish caps with openings to permit passage of rail.
  3. Fasteners: Tamper resistant cadmium plated steel screws.
  4. PVC Coated: Complying with the requirements of Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan.
- L. Stretcher Bars: One piece equal to the full length of the fabric, minimum cross section 3/16" by 3/4".
- M. Metal Bands (for securing stretcher bars): Steel, wrought iron or malleable iron.
- N. Hardware: Self locking bands, tie wires and similar accessories. All hardware ends to pipe rails and other fence components must be of solid construction that prevents access to wasps and similar insects.
  1. PVC Coated Hardware: Complying with the requirements of Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan to match color of adjacent fence components.
- O. Tension Wire: Manufacturer's standard 7 gauge coiled spring steel wire.
- P. Wire Ties:
1. For tying fabric to line posts, rails, and braces: 9 gauge steel wire installed at 12" O.C.
  2. For tying tension wire to fabric: 11 gauge steel hog rings at 24" O.C.
- Q. Truss Rods: 3/8" diameter.
- R. Bolts and Nuts: ASTM A 307, Grade A.
- S. Concrete: Portland cement concrete having a minimum compressive strength of 3000 psi at 28 days.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Installer Verification of Conditions: Examine conditions under which chain link fences and gates are to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

### **3.02 PREPARATION**

- A. Clear and grub plant material along the fence line as required to eliminate growth interfering with the fence alignment. Remove all debris from the project property.

- B. Do not begin installation of the fence until finish grading in area has been completed.

### **3.03 INSTALLATION**

- A. Space posts equidistant in the fence line at a maximum of 10 feet on center unless specifically noted otherwise on the Contract Documents.
- B. Setting Post in Earth: Drill holes for fence footings. Set posts in the center of the hole and fill the hole with concrete. Plumb and align posts, vibrate or tamp concrete for consolidation. Finish concrete in a dome shape above the finish grade elevation to shed water. Do not attach fabric to posts until the concrete has cured a minimum of seven days.
- C. Located corner posts at corners and at changes in direction. Use pull posts at all abrupt changes in grade and at intervals no greater than 500 feet. On runs over 500 feet, space pull posts evenly between corner or end posts. On long curves, space pull posts so that the strain of the fence will not bend line posts.
- D. Install top rail continuously through post tops or extension arms, bending to radius for curved runs. Install expansion couplings as recommended by the fencing manufacturer.
- E. Install bottom and intermediate rails in one piece between posts and flush with the post on the fabric side using special offset fittings where necessary.
- F. Brace corner posts, pull posts, end posts and gate posts to adjacent line posts with horizontal rails.
- G. Diagonally brace corner posts, pull posts, end posts and gate posts to adjacent line posts with truss rods and turnbuckles.
- H. Attach the fabric to the active playfield or security side of the fence. Maintain a 1 inch clearance above the finished grade except where indicated otherwise. Thread stretcher bars through the fabric using one bar for each gate and end post and two for each corner and pull post. Pull fabric tight so that the maximum deflection of the fabric is 2 inches when a 30 pound pull is exerted perpendicular to the center of a panel.
  - 1. Maintain tension by securing stretcher bars to posts with metal bands spaced at 15" O.C.
  - 2. Fasten fabric to steel framework with wire ties spaced 12" O.C. for line posts and 24" O.C. for rails and braces. Bend back wire ends to prevent injury.
  - 3. Tighten stretcher bar bands, wire ties and other fasteners securely.
  - 4. When the fabric height exceeds 12', overlap horizontal splices 6" at the intermediate rail and secure with wire ties spaced at 12" O.C.
- I. Position bolts for securing metal bands and hardware so nuts are located opposite the fabric side of the fence. Tighten nuts and cut off excess threads so no more than 1/8" is exposed. Peen ends to prevent loosening or removal of nuts. Secure post tops and extension arms with tamper resistant screws.
- J. Install gates plumb and level and adjust for full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.
- K. Wire brush and repair welded and abraded areas with one coat of cold galvanizing compound.
- L. Restore disturbed ground areas to their original condition. Topsoil and seed to match adjacent areas.

### **3.04 ADJUSTING AND CLEANING**

- A. Repairs and Protection of chain link fences and gates.
  - 1. Repair or replace broken or defective chain link fences and gates as directed by the Project Designer.
  - 2. Protect chain link fences and gates from damage until acceptance of the fencing construction.

### **END OF SECTION**

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**SECTION 32 9230  
ATHLETIC FIELD CONSTRUCTION**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Subsoil preparation
- B. Placement of topsoil
- C. Seeding and application of soil amendments and fertilizer
- D. Turf maintenance during warranty period
- E. Cleanup and protection
- F. Inspections and final acceptance

**1.02 RELATED SECTIONS**

- A. Section 31 0000 - Earthwork

**1.03 SUBMITTALS**

- A. Comply with the requirements of Section 01 3000 and as modified below.
- B. Quality Control Submittals
  - 1. Experience Listing: Submit a list of completed projects including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified in the "Quality Assurance" section of this specification.
  - 2. Topsoil Analysis Report: Submit topsoil analysis report for on-site stockpiled or imported topsoil. Do not mix or utilize topsoil until a soil analysis report is approved by the Project Designer.
    - a. Provide required representative samples of topsoil and organic or inorganic amendment materials proposed for use in the project to the independent testing agency noted below for analysis and recommended treatment. The Contractor shall pay for all costs incurred for testing and analysis of the soil material. Test reports shall be from current year.
      - 1) All soil samples and proposed amendments shall be sent to the Owner's Testing Agent:
        - (a) Hummel & Company, Inc.
        - (b) 35 King Street
        - (c) Trumansburg, New York 14886
        - (d) Telephone Number: 607-387-5694
      - b. All reports shall be sent to the Project Designer for approval.
      - c. Samples of imported topsoil to be brought to the site must be approved prior to delivery.
      - d. Deficiencies in the topsoil shall be corrected by the Contractor, as directed by the Project Designer, after review of the testing agency report.
      - e. Ensure test reports include specific recommendations regarding exact types, times and rates of application of soil additives and fertilizers based upon soil test results and type of seed mix to be planted. Follow soil additive recommendations before and during topsoil respread operations. Include the following in the topsoil analysis:
        - 1) pH factor
        - 2) Percent organic matter as determined by a Loss on Ignition or Walkey/Black Test (ASTM F-1647.
        - 3) Proctor testing per ASTM D698.

- 4) Chemical analysis testing nitrogen, phosphorus, potassium, calcium, magnesium, cation exchange capacity, base saturation percentages, micronutrients and acidity (pH).
  - 5) Particle size analysis of the topsoil as determined by ASTM F-1632, performed and compared to the USDA Soil Classification System.
  - f. Include in the recommendations the type, composition, rate and means of application of soil amendments and fertilizer necessary to establish the required pH factor, organic matter content and supply of nutrients satisfactory for planting.
  - g. All materials and procedures regarding soil amendments and fertilizers specified in this section are approximate; adjust all soil amendments to comply with the test reports.
3. Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.
- C. Closeout Procedures: Comply with the requirements of Section 01 7800.

#### **1.04 QUALITY ASSURANCE**

- A. Worker's Qualifications: The person's performing the athletic field construction and their direct supervisor shall be personally experienced in the construction and caring of athletic field areas. On site supervisory personnel shall have been employed by the company engaged in the installation and care of athletic field areas for a minimum of five years. All other individuals on the landscape crew must have a minimum of one year experience in the athletic field construction industry.

#### **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Packing and Shipping: Ship seed and associated materials with certificates of inspection required by governing authorities.
- B. Do not make substitutions. If specified seed material is not obtainable, submit to the Project Designer proof of non-availability and a proposal for use of equivalent material.
- C. Store all seed at the site in a cool, dry place as approved by the Owner's Representative. Replace any seed damaged during storage.
- D. Deliver seed in vendor's unopened packages bearing labels showing the vendor's name and seed analysis by weight.
- E. Deliver fertilizer in the manufacturer's standard sized bags showing the weight, analysis, and manufacturer's name. Store all fertilizer under a waterproof cover or in a dry place as approved by the Owner's Representative.

#### **1.06 PROJECT CONDITIONS**

- A. Water: If available on the site, water will be supplied for the purpose of watering newly planted lawn areas at no cost to the contractor. If water is not available on site, the contractor shall supply water at their own cost as required to maintain the health of the newly planted material.
- B. Provide irrigation materials capable of adequately watering new lawn areas until acceptance.

#### **1.07 PESTICIDE APPLICATIONS**

- A. Any contractor applying pesticides must notify the Owner's designated pesticide representative and all property neighbors not less than 48 hours in advance of any pesticide application including herbicides, insecticides and fungicides in accordance State Regulations.

#### **1.08 SEQUENCING AND SCHEDULING**

- A. Proceed with and complete athletic field construction as rapidly as portions of the site become available, working within seasonal limitations for the work required.

- B. Seed lawn areas during a period between August 15 and October 1. Seeding during unseasonable conditions must be reviewed and approved with the Project Designer at the sole risk of Contractor.
- C. The Contractor shall complete a minimum of three mowings before requesting the Project Designer review for acceptance of seeding work.

## **PART 2 PRODUCTS**

### **2.01 SEED**

- A. Grass seed shall be certified "Blue Tag" seed composed of a blend of varieties mixed in proportion by weight and tested for minimum percentages of purity and germination. Submit the proposed mixture to the Project Designer for approval.
  - 1. Fall Seeding: Seed blend shall consist of 100% Kentucky Bluegrass on a weight basis. The seed shall be a blend of at least three Kentucky Bluegrass varieties of which no less than 60% of the seed shall be at least two of the following cultivars; Rambo, Princeton-105, Wildwood, Allure, Coventry, Champagne, Northstar, Cardiff, Nimbus, Raven, SR2100, Misty, America, Brilliant, Limousine, Conni, Liberator, Apollo, NuGlade, Total Eclipse, Unique, Impact, Midnight, Arcadia and Serene.

### **2.02 SOD**

- A. Refer to drawings for athletic field areas to receive sod and product information.

### **2.03 MULCH**

- A. Dry Application Straw: Stalks of oats, wheat, rye or other approved crops which are free from noxious weeds. Weight shall be based on 15% moisture.
- B. Hydro-Application: Colored wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch.
  - 1. For convenience, details and specifications have been based on the following manufacturers and their products:
    - a. Conwed Hydro Mulch as manufactured by Conwed Fibers, Hickory NC.

### **2.04 TOPSOIL**

- A. Use either approved topsoil imported to the project site or approved on-site topsoil stripped, stockpiled and amended to meet the required specifications.
  - 1. On-site topsoil shall be from existing stockpiles stripped from the project site and approved by the Project Designer.
  - 2. Where quantity of topsoil required exceeds that available from on-site stockpiles, provide imported topsoil from local sources or from areas having similar soil characteristics to that found on the project site which are producing or have produced fair to good yield farm crops without unusual fertilization for a minimum period of ten years or from arable or cultivable areas supplied with good natural drainage. Do not obtain topsoil from bogs or marshes or from farmland that has utilized "Atrazine" or similar herbicide within the past five years.
- B. Provide topsoil conforming to the following:
  - 1. Original loam topsoil, well drained homogeneous texture and of uniform grade, without the admixture of subsoil material and entirely free of dense material, hardpan, sod, or any other objectionable foreign material.
  - 2. Containing not less than four percent nor more than 20 percent organic matter in that portion of a sample passing a ¼" sieve when determined by the wet combustion method on a sample dried at 105 degrees F.
  - 3. Containing a pH value within the range of 6.3 and 7.0 on that portion of the sample which passes a ¼" sieve.
  - 4. On-site and imported topsoil shall be mechanically screened prior to respreading to comply with the following gradation:

SIEVE DESIGNATION	PERCENT PASSING
¾ INCH	100
¼ INCH	97 – 100
NO. 200	20 - 65

**2.05 SAND**

- A. ASTM C-33 concrete sand with the following modifications:
  1. Fineness modulus of 2.5 to 3.2.
  2. Coefficient of uniformity (D60/D10) of less than 4.
- B. The Contractor must deliver a sample of the proposed sand amendment material to the Owner’s Testing Agent (Hummel and Company) for analysis. The Contractor will be responsible for all testing costs.

**2.06 COMPOST**

- A. Organic composted material meeting the following criteria:
  1. Organic matter content of no less than 50% as determined by ASTM D2974.
  2. Moisture content of 35 - 70% as determined by ASTN D2974.
  3. A carbon/nitrogen ratio of 15:1 to 30:1.
  4. Soluble salts not exceeding 6 mS.
  5. A Solvita index of 6 to 8.
  6. 95 - 100% passing a 3/8” screen.
  7. pH of 6.0 to 8.0.
  8. Non-phytotoxic.
- B. The Contractor must deliver a sample of the proposed compost amendment material to the Owner’s Testing Agent (Hummel and Company) for analysis. The Contractor will be responsible for all testing costs.

**2.07 FERTILIZER**

- A. Superphosphate: Fertilizer composed of triple superphosphate (0-46-0) as commonly used for agricultural purposes. The superphosphate shall be delivered in the original unopened bags or containers bearing the manufacturer’s guaranteed analysis. Any fertilizer material that gets wet, caked or otherwise damaged will be rejected for use in the project.
- B. Starter Fertilizer: 18-24-12 fertilizer or similar analysis with a minimum of 75% of total nitrogen, 16% derived from urea and methylene ureas and a minimum of 24.4% from monoammonium phosphate.

**2.08 LIME**

- A. Dolomitic Limestone: Approved agricultural dolomitic limestone containing no less than 50% of total carbonates and 25% total magnesium with a neutralizing value of at least 100%. The material shall be ground to such a fineness that 40% will pass through a number 100 U.S. standard sieve, and 98% will pass through a number 20 U.S. standard sieve. The lime shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer’s guaranteed analysis. Any lime which becomes caked or otherwise damaged making it unsuitable for use will be rejected.
- B. Calcitic Limestone: Approved agricultural calcitic limestone containing a minimum of 86% calcium carbonate expressed as CaCO3. The material shall be ground to such a fineness that 40% will pass through a number 100 U.S. standard sieve, and 98% will pass through a number 20 U.S. standard sieve. The lime shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer’s guaranteed analysis. Any lime which becomes caked or otherwise damaged making it unsuitable for use will be rejected.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Installer Verification of Conditions: Examine conditions under which athletic field construction is to be completed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
  - 1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

### **3.02 SOIL PREPARATION**

- A. Strip full depth of existing topsoil and stockpile at location as indicated on the Contract Drawings or as directed by the Owner's Representative.
- B. Screen topsoil to comply with gradation specifications and mechanically blend required compost and or sand prior to respread of the material.
  - 1. The screened topsoil shall be amended with the specified sand and compost to produce a soil meeting the following criterion, as determined by ASTM F1632 or D422.
    - a. Sand (0.05 to 2.0 mm) 65 - 75%
    - b. Silt (0.002 to 0.05 mm) 15 - 30%
    - c. Clay (<0.002 mm) 5 - 20%
    - d. Gravel (>2.0 mm) <20% (maximum gravel size to be 3/8")
  - 2. The screened and amended topsoil shall have an organic matter content of 6 to 8% as determined by ASTM F1647.
  - 3. The screened and amended topsoil shall have an infiltration rate of greater than 0.5 inches per hour with the soil at 85% maximum standard proctor density. Adjustments to the mix shall be made to accomplish this infiltration benchmark.
  - 4. The screened and amended topsoil shall serve as the baseline for subsequent quality control testing. Samples shall be taken from every 1000 CY prior to placement for conformity to the specifications. Quality control testing by the Owner's Testing Agent (Hummel and Company) shall include particle size analysis and organic matter content. The Contractor will be responsible for all testing costs.
  - 5. The final soil mix shall be submitted to the Owners Testing Agent (Hummel and Company) for nutrient testing to determine the fertility status of the soil. The Contractor will be responsible for all testing costs. Final fertilizer and pH amendment recommendations will be made by the Owner's Testing Agent.
- C. Perform earthwork operations to accomplish design elevations as indicated on the Contract Documents. Loosen subgrade of areas to be seeded to a minimum depth of four inches. Remove stone and any other deleterious matter encountered over 1½" in any dimension within the subgrade.
- D. Respread screened topsoil to a minimum depth of six inches as required to meet lines, grades, and elevations shown after light rolling and settlement. Topsoil shall be spread utilizing only tracked equipment with a low ground pressure. Under no circumstances shall trucks drive over spread topsoil areas. Topsoil shall not be worked when wet. The final compaction level shall not exceed 85% maximum standard proctor density as determined by ASTM D698.
- E. Provide lime or sulfur soil amendments as required to adjust pH of the screened topsoil to 6.3 to 7.0. Apply lime or sulfur materials at a rate of 80 pounds per 1000 square feet (final application rate to be determined by the soil test report). Cultivate soil amendments to a four inch depth.

- F. After the topsoil has been placed on the field but prior to finish grading, apply triple phosphate fertilizer at a rate of 20 pounds per 1000 square feet (final application rate to be determined by the soil test report). Cultivate fertilizer to a four inch depth.
- G. Grade lawn areas to a smooth even surface with loose, uniformly fine texture. Roll, rake, remove ridges and fill depressions as required to meet finish grades. Limit fine grading operations to areas which can be planted immediately after grading. All finish grading shall be completed with small tractors outfitted with flotation tires or low ground pressure dozers. Finish grading machines shall be equipped with laser machine control systems.
- H. Surface apply 18-24-12 starter fertilizer evenly at a rate of 5 pounds per 1000 square feet prior to seeding.
- I. Restore topsoiled areas to the specified condition if eroded or otherwise disturbed after fine grading and prior to seeding.
- J. Preparation of Areas with Unchanged Grades: Where lawns are to be seeded in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare the soil bed for seeding as follows:
  - 1. Prior to preparation of unchanged grades, remove existing grass, vegetation and turf. Dispose of such material outside of the Owner's property, do not turn over into the soil being prepared for lawns unless specifically indicated to do so on the Contract Drawings.
  - 2. Till soil to a depth of not less than six inches.
  - 3. Apply soil amendments and initial fertilizers as recommended.
  - 4. Remove high areas and fill in depressions.
  - 5. Till soil to a homogeneous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.

### **3.03 SEEDING**

- A. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.
- B. Application Rate: Six pounds of seed per 1000 square feet.
- C. Dry Mechanical Application of Seed: Sow seed with billion seeder with notched rollers in three passes, second pass at 90 degrees to the first and the third at 45 degrees to the second. Sow at a rate of two pounds per 1000 square feet for each pass for a total of six pounds per thousand square feet. Incorporate the seed into the upper one inch of the prepared soil bed and water with a fine spray.
- D. Hydroseeding
  - 1. Apply seeding material with an approved hydroseeder.
  - 2. Fill tank with water and agitate while adding seeding materials. Use sufficient fertilizer, mulch and seed to obtain the specified application rate. Maintain constant agitation to keep the contents in a homogeneous suspension. Prolonged delays in application or agitation that may cause injury to the seed will be the basis for rejection of the material remaining in the tank.
  - 3. Distribute uniformly a slurry mixture of water, seed, fertilizer and mulch at a minimum rate of 57 gallons per 1000 square feet. (2500 gallons per acre).The Owner's Representative may order the amount of water increased if distribution of seeding materials is not uniform.

### **3.04 SODDING**

- A. Refer to drawings for sod installation areas, details and materials.

### **3.05 MAINTENANCE**

- A. Begin maintenance immediately after sodding. If seeded or sodded in the fall, continue maintenance the following spring until acceptable lawn conditions are established.

- B. Continually water to ensure proper seed and sod establishment and to keep the surface of the sod bed and the topsoil layer below damp. Continue watering new sod until acceptance by the Owner. Apply water slowly so that the surface of the soil will not puddle.
- C. Cut grass for the first time when it reaches a height of 2½” and maintain at a minimum height of 2”. Do not cut more than 1/3 of the blade at any one mowing. Remove clippings.
- D. Apply herbicide as soon as weeds germinate, during calm weather when the air temperature is above 50 degrees F. using a licensed applicator to apply the herbicide. When using herbicides, apply in accordance with the manufacturer’s instructions.
- E. Reseed damaged grass areas showing root growth failure, deterioration, bare spots and eroded areas.
- F. Refertilize newly seeded areas 28 days after the initial seeding. Apply a minimum of one pound of nitrogen per 1000 square feet of sod area. Use a complete fertilizer with a 1-2-1 ratio or as recommended by soil test results.
- G. Contractor to apply a follow up seeding between April 1 and May 1 the following Spring after the initial Fall seeding. Seed to be sowed with a billion seeder with notched rollers in one pass at a rate of 1 pound of seed per 1000 square feet. Incorporate the seed into the upper one inch of the prepared soil bed and water with a fine spray.
- H. Follow the Spring seeding with an additional fertilizer application using a complete fertilizer with a 2-1-1 ratio or as recommended by the soil test results. Apply a minimum of one pound of nitrogen per 1000 square feet of athletic field area.

**3.06 CLEANUP AND PROTECTION**

- A. During athletic field construction and seeding work, keep pavements clean and the project area in an orderly condition.
- B. Protect seeded areas and materials from damage due to landscape operations, operations by other contractors, trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged athletic field areas as directed.

**3.07 INSPECTIONS AND FINAL ACCEPTANCE**

- A. When required maintenance work and seed establishment is completed, request the Project Designer to make an inspection to determine acceptability. Final acceptance of athletic field areas will be granted when a uniform stand of acceptable grass is obtained with a minimum of 95% coverage.
- B. Where inspected athletic field construction does not comply with the requirements of the Contract Documents, repair rejected work. The Contractor’s maintenance responsibility shall continue until reinspected by the Project Designer and found acceptable. Maintenance responsibilities shall include refertilization, overseeding, watering and mowing of athletic field areas.

**END OF SECTION**

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**SECTION 33 0110.58  
DISINFECTION OF WATER UTILITY PIPING SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Disinfection of site domestic water lines and site fire water lines specified in Section 33 1416.
- B. Testing and reporting results.

**1.02 RELATED REQUIREMENTS**

- A. Section 33 1416 - Site Water Utility Distribution Piping.

**1.03 REFERENCE STANDARDS**

- A. AWWA B300 - Hypochlorites 2018.
- B. AWWA B301 - Liquid Chlorine 2018.
- C. AWWA C651 - Disinfecting Water Mains 2014, with Addendum (2020).

**1.04 SUBMITTALS**

- A. See Section 01 3300 for submittal procedures.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. Disinfection report:
  - 1. Type and form of disinfectant used.
  - 2. Date and time of disinfectant injection start and time of completion.
  - 3. Test locations.
  - 4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
  - 5. Date and time of flushing start and completion.
  - 6. Disinfectant residual after flushing in ppm for each outlet tested.
- D. Bacteriological report:
  - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
  - 2. Time and date of water sample collection.
  - 3. Name of person collecting samples.
  - 4. Test locations.
  - 5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
  - 6. Coliform bacteria test results for each outlet tested.
  - 7. Certification that water conforms, or fails to conform, to bacterial standards of New York State Department of Health.

**1.05 QUALITY ASSURANCE**

- A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.
- B. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of New York.
- C. Submit bacteriologist's signature and authority associated with testing.

**PART 2 PRODUCTS**

**2.01 DISINFECTION CHEMICALS**

- A. Chemicals: AWWA B300 Hypochlorite and AWWA B300 Hypochlorite.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that piping system and water well has been cleaned, inspected , and pressure tested.
- B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

### **3.02 DISINFECTION**

- A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.
- B. Provide and attach equipment required to perform the work.
- C. Inject treatment disinfectant into piping system using the continuous feed method at minimum 50 mg/L free chlorine residual.
- D. Maintain disinfectant in system for 24 hours. Free chlorine residual shall be no less than 25 mg/L at the conclusion of the 24 hour disinfection.
- E. Operate all valves in the section being tested to ensure disinfection of the appurtenances.
- F. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
- G. Collect samples for bacteriological analysis in accordance with AWWA C651.
- H. Repeat procedure if minimum free chlorine residual or bacteriological results are not satisfactory.
- I. Dispose of chlorinated water in accordance with local, state and federal regulations.
- J. Replace permanent system devices removed for disinfection.

### **3.03 FIELD QUALITY CONTROL**

- A. Test samples in accordance with AWWA C651.

**END OF SECTION**

**SECTION 33 1416  
SITE WATER UTILITY DISTRIBUTION PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Water pipe for site conveyance lines.
- B. Pipe valves.

**1.02 RELATED REQUIREMENTS**

- A. Section 32 2317 - Trenching .
- B. Section 33 0110.58 - Disinfection of Water Utility Piping Systems: Disinfection of site service utility water piping.

**1.03 REFERENCE STANDARDS**

- A. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2023.
- B. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges 2020.
- C. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast 2017, with Errata (2018).
- D. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances 2017.

**1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- E. Hydrostatic test results.
- F. Fluorocarbon coated T-bolts.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store valves in shipping containers with labeling in place.
- B. Pipe and accessories shall be handled in such manner as to insure delivery to the trench in sound, undamaged condition. If coating or lining of any type of pipe or fitting is damaged, repairs shall be made as necessary. No other pipe or material shall be placed inside of a pipe or fitting after coating has been applied. Rubber gaskets that are not to be installed immediately, shall be stored in a cool, dark place.
- C. Polyethylene piping shall be handled carefully with any gouge larger than 10% of the pipe wall removed from the trench and taken off site.

**PART 2 PRODUCTS**

**2.01 WATER PIPE**

- A. Ductile Iron Pipe: AWWA C151/A21.51:
  - 1. Ductile Iron Water Pipe: Ductile iron pipe shall conform to the latest revision of AWWA Specifications C151 cement lined with slip-type single rubber gasket joints or mechanical joints, as follows:
    - a. 4 inch, 6 inch, 8 inch, 10 inch, and 12 inch Class 50.

2. Joints and Fittings: Use ANSI/AWWA C110 and C153 fittings except ductile iron only, ANSI/AWWA rubber gasket joints. Use flanged joint bolts, nuts, and gaskets conforming to ANSI/AWWA C110, Appendix A.
  3. Use ring gaskets for pipe sizes 14 inches and larger. Do not use flanged joints for underground installation unless so specified. Unless otherwise specified, use fittings with a standard cement mortar lining per ANSI/AWWA C 104.
  4. Unless otherwise specified, use ductile iron fittings with a rated working pressure of at least 250 psi.
  5. Restrained joints (those types which provide thrust restraint without the use of the rods or thrust blocks) may be used provided that:
    - a. The joints conform to ANSI/AWWA C111 and ANSI/AWWA C151.
    - b. The rated working pressure of the restrained joint is at least 250 psi for 24 inch diameter and smaller or 200 psi for 30 inch diameter and larger.
    - c. Joint restraint is adequate to resist the maximum hydrostatic force developed at the full working pressure specified above.
    - d. The wall thickness of any pipe or fitting which is grooved to accept a lock ring is increased to compensate for the depth of the groove.
  6. **Unless otherwise specified use Fluorocarbon T-bolts.**
  7. Fittings: Ductile iron, standard thickness.
- B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Water Service" in large letters.
1. Tracer wire shall be required on all non-ferrous water mains and services.
  2. Tracer wire shall be 12 AWG wire coated with minimum 30 mil polyethylene jacketed designed specifically for buried use. Tracer wire shall be stainless steel in directional drill areas and copper in all other areas.
  3. Tracer wires shall be interconnected at all pipe tees, pipe crosses, and pipe services. Splices in the tracer wire shall be connected by means of a split bolt or compression type connector to ensure continuity. Wire nuts shall not be used. A waterproof or corrosion proof connector shall be used.
  4. Tracer wire shall be placed outside the curb stop riser and be wrapped around the top of the riser.
  5. Tracer wire shall be attached to the top of the pipe at 10 feet intervals and at all crosses, tees, and elbows.
  6. After backfill and compaction, but prior to paving, continuity testing of the tracer wire will be required. Any detected damages to tracer wire shall be repaired.

## 2.02 VALVES

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gate Valves 3 Inches and Over:
  1. Resilient seated gate valves for sizes 3 inches through 16 inches shall be manufactured and tested to the requirements of AWWA Standards C509 (cast iron), C515 (ductile iron), and C500 (most recent revisions) as applicable for a design working pressure of 250 psi. This pressure rating shall be cast on the outside of the valve.
  2. Manufacturers:
    - a. Kennedy.
    - b. Mueller.
    - c. U.S. Pipe.
    - d. or approved equal

## 2.03 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 0000.

B. Cover: As specified in Section 31 0000.

## **2.04 WATER FOR HYDROSTATIC TESTING, FLUSHING AND DISINFECTION:**

A. The Contractor shall be responsible for providing potable water for cleaning and testing. The contractor shall coordinate with the Owner prior to the use of on-site water source and be responsible for all costs associated with the use of on-site water should the Owner allow its use.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

### **3.02 PREPARATION**

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the engineer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare pipe connections to equipment with flanges or unions.

### **3.03 TRENCHING**

A. See the section on trenching for additional requirements.

### **3.04 INSTALLATION - PIPE**

- A. Handling: Pipe and accessories shall be handled so as to insure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. No other pipe or material of any kind shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects.
- B. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Owner. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.
- C. Sewer Lines: Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 10 feet from a sewer pipe.
- D. Where water lines cross gravity-flow sewer lines, the water pipe shall be laid with a minimum separation distance of 18 inches for 10 feet each side of sewer pipe.
- E. Route pipe in straight line.
- F. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- G. Slope water pipe and position drains at low points.

### **3.05 INSTALLATION - VALVES AND HYDRANTS**

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.

**3.06 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Leakage Test: All pipe line shall be tested hydrostatically for 2 hours at a pressure 50 percent in excess of the pressures to which the pipe will normally be subjected, unless different test pressures are outlined in the Special Requirements; but in no case less than 150 pounds per square inch (psi). Any obvious leaks or ruptured piping disclosed by the tests shall be repaired or replaced, and the test repeated to the engineer's satisfaction.
  - 1. The contractor shall accomplish the required tests on the pipeline by individually testing each component section of main designed by the Engineer. The Maximum length of section permitted to be tested at any one time will be approximately one mile, and normally will be less. All water for tests shall be furnished and disposed of by the Contractor at his expense. Source and/or quality of water which the contractor proposes to use in testing the lines shall be acceptable to the Engineer.
  - 2. Leakage tests shall be conducted concurrently with the pressure tests. The duration of each test shall be at least two hours in length to coincide with the time of the pressure test. Leakage test shall be repeated as often as necessary until the leakage requirement is met.
  - 3. Leakage is defined as the quantity of water that must be supplied into a newly laid pipe or any valved section thereof to maintain the pressure within 5 psi of the test pressure after all the air in the pipeline has been expelled and the pipeline filled with water.
    - a. Allowable leakage will be determined by the formula:
      - 1)  $L = [ SD (P)^{1/2} ] / 148,000$ .
      - b. in which L is the allowable leakage in gallons per hour (gph); S is the length of pipeline tested in feet; D is the nominal pipe diameter in inches; and P is the average test pressure during the leakage test in pounds per square inch gage (psig).
      - c. Pressure testing for HDPE mains shall be per manufacturer's recommendations or as follows:
        - 1) Gradually pressurize the test section to test pressure. Initial test pressure shall be allowed to stand without makeup pressure for three (3) hours, to allow for diametric expansion or pipe stretching to stabilize.
        - 2) After this equilibrium period, apply the specified test pressure. The final test pressure shall be held for 2 hours, monitoring the amount of make-up water required to maintain test pressure.
        - 3) Allowable leakage shall be determined from the chart below, Make-up Water Allowance, Technical Note 802, published by Performance Pipe.

Nominal Pipe Size (in.)	Make-Up Water Allowance - 2 Hour Test (US Gal/100 ft of pipe)
4	0.25
6	0.6
8	1.0
10	1.3
12	2.3

- 4. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/inch of nominal valve size shall be allowed. Also, where hydrants occur within a test section, the hydrant valve shall be closed.
- 5. Acceptance of individual sections shall be determined upon the basis of allowable leakage. If any tests disclose leakage in excess of the allowable, the contractor shall repair each deficient section and retest them until they fall within the allowable range. The cost of repairs and retesting shall be an expense of the Contractors.
- 6. All visible leaks are to be repaired regardless of the amount of leakage in the section.

7. Time for Making test: Except for joint material setting or where concrete reaction backing necessitates a 5-day delay, pipe lines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected and tested for leakage at any time after partial completion of backfill.
  8. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. For disinfection requirements, see Disinfection Specification.
  9. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be re-accomplished.
- C. Test shall be performed in accordance with AWWA C600.

### **3.07 QUALITY CONTROL**

- A. The Contractor shall establish and maintain quality control for operations under this section to assure compliance with contract requirements and maintain records of his quality control for all materials, equipment and construction operations including but not limited to the following:
  1. Hydrostatic tests
  2. Jointing
  3. Prevention of damage to pipe coating and lining.
- B. Temporary Plugging: At all times when pipe laying is not actually in progress, the open ends of the pipes shall be closed temporarily with pipe plugs or by other means. If water is in the trench when work is resumed, the plugs shall not be removed until all danger of water entering the pipe has passed.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

### **3.08 CLEANING**

- A. Cleanup: Upon completion of the installation of the water distribution lines and water service lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.
- B. Cleaning Pipeline: At the conclusion of the work and prior to disinfection of the water main, the Contractor shall thoroughly clean all new pipes by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered during the construction period. If, after this cleaning, any obstructions remain, they shall be corrected to the satisfaction of the Engineer. Pipes shall be flushed at a rate of 2.5 feet per second for a duration suitable to the Engineer.

**END OF SECTION**

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**SECTION 33 4000  
STORM DRAINAGE UTILITIES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Drainage pipe
- B. Filter fabric
- C. Warning tape

**1.02 RELATED SECTIONS**

- A. Section 31 0000 – Earthwork
- B. Section 31 2317 – Trenching

**1.03 REFERENCE STANDARDS**

- A. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- B. ASTM D3786/D3786M - Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method.
- C. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- D. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- E. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- F. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Drainage Pipe
- G. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

**1.04 SUBMITTALS**

- A. Comply with the requirements of Section 01 3000 – Administrative Requirements and as modified below.
- B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.
- C. Shop Drawings: Submit details of all underground structures including catch basins, drop inlets, storm manholes, drywells, trench drains, headwalls, outlet structures, frames and grates, frames and covers, culvert end sections and similar items indicated on the Contract Documents.
- D. Closeout Procedures: Comply with the requirements of Section 01 7800.

**1.05 QUALITY ASSURANCE**

- A. Regulatory Requirements: Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit to the Owner's Representative.
- B. Comply with applicable municipal regulations. Coordinate connections into existing municipal sewers with appropriate town/village/county/city or state representatives. Pay for all fees associated the connection to municipal sewer system.

**1.06 PROJECT CONDITIONS**

- A. Field Measurements: Establish and maintain required lines and elevations for grade control.

**1.07 SEQUENCING AND SCHEDULING**

- A. Proceed with and complete storm drainage installation as rapidly as portions of the site become available, working within seasonal limitations for the work required.

## **PART 2 PRODUCTS**

### **2.01 PIPING**

- A. High Density Polyethylene Pipe (HDPE): Solid or perforated double wall smooth interior pipe complying with the following:
1. 4" to 10" diameter pipe to conform to AASHTO M 252. 12" to 36" diameter pipe to conform to AASHTO M 294.
  2. Coefficient of Roughness (Interior Pipe Surface): 0.012 maximum (Manning Formula)
  3. Classification: Type S
  4. Minimum Pipe Stiffness Values
    - a. 4" – 12" Diameter: 50 psi
      - 1) 15" Diameter: 42 psi
      - 2) 18" Diameter: 40 psi
      - 3) 24" Diameter: 34 psi
      - 4) 30" Diameter: 28 psi
      - 5) 36" Diameter: 22 psi
  5. Joint Couplings: Polyethylene, bell and spigot type couplers utilizing an elastometric gasket conforming to ASTM F 477. Snap on type or split collar through 24" diameter, screw on type where applicable.
    - 1) Corrugated to match pipe corrugations, width not less than one half the pipe diameter.
    - 2) Split couplings shall engage an equal number of corrugations on each side of the joint
  6. Fittings: Either molded or fabricated, high density polyethylene components meeting the properties specified for, and designed specifically for the pipe manufactured by the pipe manufacturer.
  7. Perforated Pipe: Conform to AASHTO M-252 or AASHTO M-294, Type SP with Class I perforations.
  8. Specifications have been based on products manufactured by Advanced Drainage Systems, Inc, Columbus, Ohio (Tel. #614-457-3051) or Hancor, Inc., Findlay, Ohio (Tel. #800-847-5880).
    - a. Corrugated Polyethylene Piping: Solid and perforated piping complying with the following:
  9. Pipe Classification: AASHTO M252, Type S
  10. Material Classification: ASTM D 3350
  11. Property Description: Cell Class 324420C
  12. Pipe Size: As indicated on the Contract Documents
  13. Perforation Size: 9/16" by 1/16" slots with a minimum inlet area of 2.4" per lineal foot of pipe.
  14. Joint Couplings: External snap couplers with gaskets for solid wall and external snap couplers without gaskets for perforated pipe
  15. Specifications have been based on products manufactured by Advanced Drainage Systems, Inc, Columbus, Ohio (Tel. #614-457-3051) or Hancor, Inc., Findlay, Ohio (Tel. #800-847-5880).

### **2.02 FILTER FABRIC**

- A. Continuous filament fabric consisting of polypropylene fibers and heat bonded nylon sheathed polypropylene fibers.
1. Specifications have been based on "Mirafi 140N" manufactured by Mirafi Construction Products, Pendergrass, Georgia (Tel. #706-693-2226).

### **2.03 WARNING TAPE**

- A. Standard, 4 mil polyethylene, 3" wide tape, purple, detectable type tape, imprinted with the words "CAUTION BURIED STORM SEWER" in black letters.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Installer Verification of Conditions: Examine conditions under which storm drainage is to be installed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
  - 1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

### **3.02 PREPARATION**

- A. Excavation of trenches and for appurtenances and backfilling for storm drains shall be in accordance with the applicable portions of Project Manual Sections in Division 31.
- B. Inspect all pipe and fittings prior to installation. Remove defective pipe and fittings from the site.

### **3.03 INSTALLATION**

- A. Pipe Installation
  - 1. Lay pipes true to line and grade. Gravity flow storm drainage systems shall be laid with bells facing upgrade.
  - 2. Do not lay pipe on unsuitable material, in wet trenches or when a trench and weather conditions are unsuitable for the work.
  - 3. Support the pipe on compacted bedding material.
  - 4. Clean interior of all pipe thoroughly before installation.
  - 5. Lower pipe in to trench carefully and bring to the proper line, grade and joint. After joining, the interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
  - 6. Do not walk on pipe in trenches until covered by layers of backfill to a minimum depth of 12" over the crown of the pipe.
  - 7. Install gravity sewer pipe to comply with the manufacturer's specifications.
  - 8. Warning tape shall be continuously placed 12" above the storm sewer piping.

### **3.04 ADJUSTING AND CLEANING**

- A. Deflection Tests: Provided by the Prime Contractor in accordance with the requirements of Project Manual Section 01 4000 – Quality Requirements.
- B. Upon completion of the installation, leave all components of the storm drainage system completely free from silt, debris and other obstructions.
- C. Repairs and Protection of Storm Drainage Infrastructure
  - 1. Repair or replace broken or defective storm drainage components as directed by the Project Designer.
  - 2. Protect storm drainage from damage until acceptance of the infrastructure construction.

**END OF SECTION**