



***BID AND CONTRACT DOCUMENTS  
AND SPECIFICATIONS  
FOR***

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**JOINT OPERATIONS & MAINTENANCE FACILITY**

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***PROJECT # 36610  
RFB # 24-007***

***City of Federal Way  
Public Works Department  
33325 8th Avenue South  
Federal Way, WA 98003***

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Federal Way, WA.

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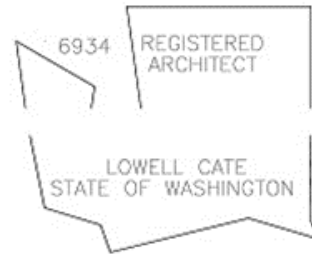
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**CITY OF FEDERAL WAY  
JOINT OPERATIONS & MAINTENANCE FACILITY  
FEDERAL WAY, WA.**



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GEOTECHNICAL ENGINEERING REPORT – MIGIZI GROUP



**SECTION 21 00 00  
FIRE SUPPRESSION WORK SPECIFIED IN DIVISION 23**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

A. Description: The following Sections apply to the Work in this Division with the exception of items specifically described in Division 21:

- |    |                |  |
|----|----------------|--|
| 1. | Section 230500 | General Provisions                         |
| 2. | Section 230505 | Project Closeout and System Start-Up       |
| 3. | Section 230510 | Basic Materials and Methods                |
| 4. | Section 230513 | Electrical Provisions for Mechanical Work  |
| 5. | Section 230800 | Mechanical Systems Commissioning           |
| 6. | Section 230810 | HVAC Systems Training                      |
| 7. | Section 230820 | Systems Operations and Maintenance Manuals |

**PART 2 - PRODUCTS**

Not used.

**PART 3 - EXECUTION**

Not used.

\*\*\*END OF SECTION\*\*\*

**SECTION 21 10 00  
AUTOMATIC FIRE SUPPRESSION SYSTEMS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes design and construction of complete automatic wet fire suppression systems.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Authorities Having Jurisdiction (AHJs):
  - 1. South King Fire & Rescue.
- C. Codes and Standards:
  - 1. International Fire Code (IFC).
  - 2. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
  - 3. ASME B16.3, Malleable Iron Threaded Fittings.
  - 4. ASTM A 47, Standard Specification for Ferric Malleable Iron Castings.
  - 5. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 6. ASTM A 135, Standard Specification for Electric-Resistance-Welded Steel Pipe.
  - 7. ASTM A 183, Standard Specification for Carbon Steel Track Bolts and Nuts.
  - 8. ASTM A 197, Standard Specification for Cupola Malleable Iron.
  - 9. ASTM A 449, Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
  - 10. ASTM A 536, Standard Specification for Ductile Iron Castings.
  - 11. ASTM A 795, Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
  - 12. NFPA 13, Standard for the Installation of Sprinkler Systems.
  - 13. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
  - 14. NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
  - 15. NFPA 70, National Electrical Code.
  - 16. NFPA 72, National Fire Alarm Code.
  - 17. NFPA, Automatic Sprinkler System Handbook.
  - 18. UL 268, Standard for Smoke Detectors for Fire Alarm Signaling Systems.
  - 19. UL 864, Control Units and Accessories for Fire Alarm Systems.
  - 20. UL 1481, Power Supplies for Fire-Protective Signaling Systems.
  - 21. Underwriters Laboratories Fire Protection Equipment Directory.

- D. Fire Sprinkler System Subcontractor's Qualifications for Preparation of Shop Drawings, Installations, Inspections, Maintenance, and Servicing (WAC 212-80-043):
1. Only licensed fire protection sprinkler system contractors shall execute contracts for installation, inspection, maintenance, or servicing of fire protection sprinkler systems or any part of such system.
  2. Only licensed contractors who have achieved at least State of Washington Level U licensure shall install, inspect, maintain, and/or servicing the underground portions of fire protection sprinkler systems in the State of Washington.
  3. Only licensed fire protection sprinkler contractors who have achieved at least State Level III licensure shall execute contracts for installation, inspection, testing, maintenance and/or servicing of NFPA 13 and other systems per definition of fire protection sprinkler system or any part of such a system in State of Washington.
  4. Only those certificates of competency holders who have achieved State Level U certification shall supervise and/or certify installation of underground supplies to fire protection sprinkler systems.
  5. Only those certificate of competency holders who have achieved at least State Level III certification shall supervise and/or certify the preparation of layout drawings (Shop Drawings) installation, inspection, testing, maintenance, servicing of, or installation of NFPA 13, and other systems per definition of fire protection sprinkler system in Chapter 18.160 RCW or any part thereof.
- E. Grooved Joint Pipe Requirements: Grooved couplings, fittings, valves, and specialties shall be products of one manufacturer including grooving tools. Castings used for coupling housings, fitting, valve bodies, and similar items shall be date stamped.

### 1.03 SYSTEM DESIGN CRITERIA

- A. Survey site prior to submitting bid. Comply with requirements in Section 230500.
- B. Design, furnish, and install complete operable fire suppression systems in accordance with the latest adopted editions of IBC, IFC, NFPA 13, NFPA 24, NFPA 72, and applicable city, county, and state laws, codes, and standards. Include valves, flow switches, valve monitor switches, and accessories to meet requirements of the AHJs and aforementioned codes and standards.
- C. In areas where local codes require coverage by either fire sprinklers or heat detectors, provide coverage by fire sprinklers.
- D. Coverage: It is the requirement of this Section for complete fire sprinkler coverage of the entire facility including:
1. Accessible chases and shafts.
  2. Attic spaces.
  3. Raised floor areas.
  4. Mechanical rooms.
  5. Electrical and telephone rooms.
- E. The Contractor and the fire suppression system subcontractor shall meet with the AHJs prior to preparation of Shop Drawings and hydraulic and earthquake bracing calculations to review procedures for handling submittals, inspection, testing, and for general coordination and to verify sprinkler occupancy hazard classifications.

- F. Obtain latest water supply engineering test data prior to design. Include 10 percent safety margin in system design. Fire flow test results as follows: Hydraulic model performed on 12/17/23 on proposed 12-inch on-site loop resulted in 31 psig static pressure and 20 psig residual pressure at 3900 gpm.
- G. Coordination With Other Trades:
  - 1. Coordinate fire suppression work with that of mechanical, sheet metal, plumbing, and electrical subcontractors so that best arrangement of equipment, piping, conduit, ducts, and similar items can be obtained.
  - 2. Identify points of conflict between this work and that of other trades so that conflict may be properly adjusted. Fire suppression system subcontractor shall remove and re-install work which interferes with work of other trades at no additional cost to the Owner.
- H. No change orders will be issued for additions and deletions of sprinkler heads and associated piping except as such additions and deletions stem from changes in building design made subsequent to approval of the Shop Drawings.

#### 1.04 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Pipe and fittings.
  - 2. Valves.
  - 3. Sprinkler heads.
  - 4. Fire department connection.
  - 5. Alarm and signal devices.
  - 6. Building fire alarm system interface.
  - 7. Piping specialties.
- C. Shop Drawings and Calculations:
  - 1. Comply with requirements in NFPA 13.
  - 2. Comply with requirements in Section 230500
  - 3. Submit preliminary layout showing only head locations for review by the A/E. Include additional heads which may be required for coordinated ceiling pattern at no additional cost to the Owner, even though number of heads may exceed minimum code requirements. Indicate sprinkler head locations as follows:
    - a. Suspended Accessible Ceilings: Locate heads in center of ceiling tiles up to 2 foot tile dimension, and 1/4 Section intervals for 4 foot tile dimension.
    - b. Suspended Inaccessible Ceilings: Locate heads in conjunction with light fixtures and other devices installed in ceiling in a symmetrical pattern.
    - c. Arrange heads in straight lines that are parallel and perpendicular to walls.

4. After the A/E review of sprinkler head locations, submit the Shop Drawings and hydraulic and earthquake bracing calculations to the A/E of entire sprinkler system. Shop Drawings shall be complete floor plans showing work, locations and types of heads, pipe sizes and cutting lengths, locations and sizes of required beam penetrations, locations and types of hangers, test valves, drain valves, and other related items. Indicate exposed work.
  5. Include risers, flow switches, inside shut-off valves, valve monitor switches, and similar components. Coordinate with work shown on civil drawings but refer to requirements of WAC 212-80-043 for installation of underground portions of fire protection sprinkler systems.
  6. Indicate location of alarm and supervisory initiating devices and other devices and electrical equipment associated with the fire suppression systems.
  7. Following review and approval by the A/E, submit Shop Drawings and hydraulic and earthquake bracing calculations to the AHJs. Do not proceed with installation until the Shop Drawings have been approved by the AHJs.
- D. Contractor's Material and Test Certificate: Submit to certify material selection and testing results using form in NFPA 13. Complete applicable portions of form and sign and date it.
- E. Obtain from each AHJ written certification that the permanent installation has been inspected and that it complies with the AHJ's published regulations and requirements. Submit prior to Substantial Completion.
- F. Test Reports:
1. Field test reports.
  2. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.
- G. Operations and Maintenance Data:
1. Prepare complete, simple, understandable, step-by-step, testing instructions with recommended and required testing frequency of equipment with methods for testing equipment. Include troubleshooting manual.
  2. Prepare complete, easy-to-read, understandable maintenance instructions including the following information:
    - a. Instruction on replacing components of system including internal parts.
    - b. List of equipment and components with address and phone number of both manufacturer and local supplier of each item.
  3. Include fire suppression system pressure and alarm system tests.
  4. Include copies of the following publications:
    - a. NFPA 13.
    - b. NFPA 25.
  5. Submit one week minimum prior to system training.
- H. Record Drawings:
1. Provide in accordance with Division 01 and Section 230500.

2. Submit one week minimum prior to system training.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Manufacturer of equipment regularly engaged in the manufacture of components specified and with published catalogs listing pertinent specifications of items manufactured. Pipe and fittings shall be manufactured in the United States.
- B. Manufacturers name and model identification used throughout this Section are to establish general configuration, function, size, performance, and quality.
- C. Manufacturers: Victaulic Co., Tyco Fire Protection Products, Viking Automatic Sprinkler Company, Reliable Automatic Sprinkler Co. Inc., or approved. In general, Victaulic model numbers are listed.

### 2.02 GENERAL

- A. Equipment, Material, and Components Required by NFPA to be Listed: Listed in UL Fire Protection Equipment Directory or approved by FM and the AHJs.

### 2.03 PIPE AND FITTINGS

- A. Pipe:
  1. Comply with requirements in NFPA 13.
  2. Black steel and galvanized steel, ASTM A 53, ASTM A 135, or ASTM A 795.
  3. Pipe, other than Schedule 40 or Schedule 10, acceptable if UL listed and labeled, and approved by the AHJs. CPVC pipe not acceptable.
  4. Schedule 40 pipe used in cut groove joints and for sizes 2 inch and smaller with screwed joints and fittings.
  5. Schedule 10 pipe used for rolled grooved joints.
  6. Internal and external galvanized steel for buried pipe if not ductile iron and drains.
  7. Flexible sprinkler connections may be used at the Contractor option. If used, shall be braided type. Install with union joint threaded fittings. Include open-gate ceiling attachment bracket to allow sprinkler connection installation prior to installation of ceiling tile. The drop includes a male threaded nipple or Victaulic FireLock IGS Style 108 captured coupling for connection to branch line piping. UL approved Series AH1 hose with 3" bend radius and AH2 or AHC-CC with 2" bend radius. Pressure fit type fittings not acceptable. Oversized ring, sleeve, or adaptor through ceiling not required. Victaulic® VicFlex™, FlexHead Industries, EASYFLEX, or approved.
  8. Ductile iron, cement lined, Class 52, mechanical or push-on restrained joints for underground pipe.
- B. Fittings:
  1. Comply with requirements in NFPA 13.
  2. Minimum 125 psi class.

3. 2 Inch and Smaller: 150 pound black malleable or ductile iron, screwed, ASME B16.3 and ASTM A 197. Threadolet type fittings acceptable for Schedule 40 pipe only.
4. 2-1/2 Inch and Larger: Grooved joint fittings, ductile iron ASTM A 536 bodies. Flanged fittings, forged steel, or ductile iron.
5. Grooved Joint Couplings: UL listed and labeled for sprinkler service. 2 ductile iron ASTM A 536 housings. EPDM or chlorinated butyl gasket. Nuts and bolts ASTM A 449 and ASTM A 183. Minimum 110,000 psi tensile.
  - a. Rigid Type Couplings: Cast housings with offsetting, angle-pattern, bolt pads, and system support and hanging as required by NFPA 13. Victaulic Co. 009-EZ and Style 107N; installation-ready, for direct stab installation without field disassembly.
  - b. Flexible Type Couplings: For seismic applications and in locations where vibration isolation and stress relief are required. Victaulic Co. Installation-Ready Style 177, or Style 75 and Style 77.
6. Victaulic FireLock™ IGS Groove System for Carbon Steel Pipe - In lieu of threaded steel piping systems, the Victaulic FireLock IGS System with "Installation-Ready™ fittings and couplings may be used for NPS 1 (DN 25) Schedule 10 and Schedule 40 carbon steel pipe in fire protection applications. System rated for a working pressure to 365 psi (2517 kPa).
  - a. Groove: IGS "Innovative Groove System" groove with shortened "A" dimension and tapered groove backside for ease of installation.
  - b. Grooving Tool: Victaulic RG2100, with IGS Confirmation Gauge.
  - c. Fittings: Ductile iron housing conforming to ASTM A-536, Grade 65-45-12. Orange enamel coated or galvanized. Victaulic Style 101 (90-degree elbow), Style 102 (tee), and Style 108 (coupling) with Installation-Ready™ ends.
  - d. Coupling: Style 108 single-bolt coupling provided with EPDM Type A pressure responsive gasket with Vic-Plus lubricant, and ASTM A449 compliant electroplated steel bolt and nut. CrMo alloy steel coupling linkage.
7. Internal and external galvanized steel fittings for exterior pipes and drains.
8. Plain End Couplings: Plain end couplings (Roust-A-Bouts, Plainloks or similar couplings) not acceptable.
9. Hole Cut Outlets: Hole cut bolted branch outlet couplings may be used as approved by the AHJs. Hole cut outlets full bodied outlet (U-bolt outlets not acceptable). Victaulic Co. Style 920 and 920N.
10. Ductile iron, cement lined, Class 52, mechanical or push-on restrained joints for underground pipe.

#### 2.04 VALVES

- A. General: UL listed and labeled and FM approved, minimum 175 psi class.
- B. Gate Valves:
  1. 2 Inch and Smaller: Bronze body, solid wedge disc, OS&Y, screwed, rising stem. Include valve monitor switch.

2. 2-1/2 Inch and Larger: Cast or ductile iron body, solid wedge disc, OS&Y, grooved ends or flanged, rising stem. Include valve monitor switch. Victaulic Co. Series 771H.
- C. Butterfly Valves: Cast or ductile iron body with internal surfaces coated and disc coated or plated. Pressure responsive elastomer seat, and the stem offset from the disc centerline to provide complete 360-degree circumferential seating. Include weatherproof actuator with slow close handwheel and gear operator and visual indication of valve position. End connections wafer, lug, or grooved. Include built-in dual valve monitor switch. Victaulic Co. Style 705.
- D. Check Valves: Spring-assisted swing check, end connections to match adjacent piping, cast iron or ductile body, bronze seat, stainless steel or elastomeric-coated clapper, stainless steel spring and shaft with replaceable rubber seal. Suitable for vertical or horizontal installation. Include tapping for bronze ball drip drain for fire department connection. Victaulic Co. Series 717.
- E. Wet Pipe Sprinkler System Alarm Valve and Appurtenances: Cast or ductile iron body, cast aluminum-bronze clapper, clamp ring, and valve seat. Include tapped bosses with standard trim including system alarm and supervisory devices, retarding chamber with auxiliary valve, pressure gages, pressure operated relief valve, alarm test valve, and drain valves. Valve internal components replaceable without removing valve. Victaulic Co. Series 751.

## 2.05 SPRINKLER HEADS

- A. Automatic sprinkler quick response and standard response heads of type as required by the AHJs and finish as required for areas and ceiling construction designated. Refer to Article "Sprinkler Heads Schedule" in this Section.
- B. Operating Temperature: Comply with requirements in NFPA 13 and the AHJ. Select to compensate for the maximum temperatures which occur in a particular area during either winter or summer conditions from such sources as unit heaters and sunlight. In no case use heads rated less than 100 F higher than anticipated ambient temperature.
- C. Sprinklers shall be glass bulb type, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. (Wrenches provided by the sprinkler manufacturer that directly engage the cast wrench boss.)
- D. Extended coverage sprinkler heads may be used subject to approval by the AHJs.
- E. Include escutcheon, self-adjusting type, spring-loaded, or friction fit for each pendent sprinkler head fitting against ceiling.
- F. Sprinkler Head Guards: Include where sprinkler heads are subject to damage and for sprinkler heads installed lower than 7 feet above finished floor, grating, and in maintenance access areas. Wire basket type with screw type fastener. Spring clip type fastener not acceptable. Chrome or nickel plated in finished areas.
- G. Escutcheons and guards shall be listed and supplied for use with the sprinkler by the sprinkler manufacturer.



- H. Sprinkler Cabinet: Include with required number of sprinkler heads of ratings and types installed. Also include escutcheons and sprinkler wrench.
- I. Manufacturers: Victaulic, Tyco, Viking, Reliable or approved equal.

**2.06 FIRE DEPARTMENT CONNECTION**

- A. Flush Wall Mounting Type: 5" Storz type as indicated on the Drawings, with 30 degree elbow. Cast brass body. 4 inch inlet size as indicated in the Contract Documents. Include identification plate with lettering. Polished brass finish. Threads compatible for use with local fire department equipment. Potter-Roemer Fire Pro 5795-30, Elkhart Brass Manufacturing Co. Inc, or approved.

**2.07 ALARM AND SIGNAL DEVICES**

- A. Water Flow Switch (Systems without Alarm Valves): Vane or paddle type flow switch, installed and connected in such a manner that flow of water equal to or greater than that from a single head will automatically energize fire alarm system. Include field adjustable time delay, adjustable from 0 to 60 seconds. System Sensor or approved.
- B. Water Flow Switch (Systems with Wet Pipe Alarm Valve): Pressure type. System Sensor or approved.
- C. Valve Monitor (Tamper) Switches: 120 V. Built-in dual supervisory switch or attachment for field installed external supervisory switch for gate valves. Include for post indicator valves shown on civil drawings. System Sensor or approved.
- D. Pressure Gages: 3-1/2 inch dial, phosphor bronze tube, brass socket, 300 psi range. Include needle valve. System Sensor or approved.
- E. Electric Alarm Bell: 120 V. Weatherproof with red enameled painted hood, back box, and pressure switch. System Sensor or approved.

**2.08 BUILDING FIRE ALARM SYSTEM INTERFACE**

- A. Coordinate with work specified in Division 28.

**2.09 PIPING SPECIALTIES**

- A. Pipe Supports: Include metal pipe supports, flexible connections, sway braces, hangers, clamps, and other pipe support items in accordance with requirements in NFPA 13 and the AHJ. Seismically design pipe hangers and braces per IBC, ASCE 7, and NFPA 13. Do not use "C-Clamp" hangers unless they include integral seismic retaining strap.
- B. Identification Signs: Enameled signs for drain valves, test valves, control valves, and alarm valves indicating their use.
- C. Miscellaneous Connections and Fittings: Inspector's test connections, discharge outlets, sight glasses, and other items in accordance with requirements in NFPA 13.
- D. Air Venting: Automatic float type air vent with 40 mesh Y-type strainer and 1/2 inch NPT male connection with drain attachment. Include 1/2 inch ball valve upstream of strainer to allow

replacement of air release valve without disabling sprinkler system. UL listed and FM approved. Potter Electric Signal Company, LLC Model PAV or approved.

- E. Pipe Sleeves: Comply with requirements in Section 230510.
- F. Pipe Escutcheon Plates: Comply with requirements in Section 232116.
- G. Access Doors: Comply with requirements in Section 230510 for construction features.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Cooperate with other trades to ensure adequate space for piping placement.
- C. Review Drawings, Specifications, and Shop Drawings of other trades to coordinate work and minimize unnecessary offsets and revisions to approved Shop Drawings. Failure to coordinate does not relieve fire suppression subcontractor from meeting performance standards specified in this Section.
  - 1. Fire suppression piping shall not:
    - a. Reduce headroom to less than 7'-0".
    - b. Project into any passageway, ladder run, access or egress.
    - c. Interfere with electrical equipment or access to mechanical units (including filters).
  - 2. Install pipe and sprinkler heads to avoid conflicts with maintenance personnel's access to equipment. Do not run fire suppression piping at floor in mechanical rooms and maintenance access areas.
  - 3. Relocate piping and sprinkler heads which, in the opinion of the A/E, do not comply with preceding paragraph in manner acceptable to the A/E. Such relocation may be directed during the Shop Drawing review and during construction. If doubt should

exist as to compliance of above, suppression system subcontractor shall review situation with the A/E prior to rough-in.

- D. Do not order, fabricate, or install materials until approvals are received from the AHJs.
- E. Install material in strict accordance with the Shop Drawings approved by the AHJs and reviewed by the A/E.
- F. Service Interruptions: Comply with requirements of Section 230500. Obtain advance approval from the Owner and local fire department.

### 3.04 EARTHWORK

- A. Comply with requirements in Section 230510.

### 3.05 FIRE SUPPRESSION SYSTEMS INSTALLATION

- A. Install underground service entrance piping according to NFPA 24.
- B. Install piping concealed above furred ceilings to minimize obstructions. Offset, crossover, and route piping to install system in available space. Install to minimize obstruction to work of other trades. Expose only heads. Only fire suppression piping specifically called out on the Contract Documents as being exposed shall be below ceiling construction. Install piping through holes in beams where noted on the Drawings.
- C. Hang piping from roof structure and not from roof deck itself and not from work of other trades. Hanging pipes from ducts and equipment not acceptable except branch piping serving single sprinkler head below ducts and equipment. For branch piping hung below ducts and equipment, coordinate with those trades for design of duct and equipment hangers and supports to comply with requirements of NFPA 13.
- D. Install piping system braced to withstand damage from earthquakes. Install flexible couplings and earthquake bracing in accordance with IBC, ASCE 7, and NFPA 13.
- E. Grooved Joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices in grooved joint installation are being followed. Contractor shall remove and replace any improperly installed products.
- F. Hole Cut Outlets: Use cutting tool to form opening in pipe. After "coupon" has been removed, securely attach it to bottom of pipe as evidence that it has not been left in pipe.
- G. Install system and auxiliary drains to discharge to paved areas, concrete splash blocks, suitable waste within building, or to other locations as indicated or required by the A/E. Exterior drain locations shall be approved by the A/E. Install drain outlets on the building exterior between 6 and 18 inch above finished grade. Direct connection to sewer systems not acceptable. Install drain valves at interior walls maximum 5 feet above finished floor or

grating. Do not install drain valves on outside of building. For concealed drain valves, install access panels. Install dirt legs and drain valves at low points of piping to permit complete drainage of system without disconnection of any piping.

- H. Install ball drip valve on check valve to drain piping for fire department connection. Drain to floor receptor or outside building.
- I. Escutcheon Plates: Install at exposed pipe penetrations of ceilings, floors, and walls.
- J. Install head guards on sprinkler heads installed lower than 7 feet above finished floor and grating, and in maintenance access areas. Install on exterior sprinkler heads.
- K. Install sprinkler cabinet adjacent to alarm valve assembly.
- L. Install inspector test valve at highest and most hydraulically remote part of system in relation to riser assembly. Locate test valves to be accessible from floor. Coordinate locations with the A/E. Pipe to standpipe drain.
- M. Install sleeves through walls and floors. Comply with requirements in Section 230510.
- N. Install water motor gong/electric alarm bell on exterior wall of building. Obtain A/E approval of location.
- O. Install fire department connection on exterior wall of building as indicated on the Drawings.
- P. Install concrete thrust blocks and restraining rods for ductile iron fittings per NFPA 24 and as detailed on the Drawings.
- Q. Identification Signs: Install with chain on stem of valves. Comply with requirements in NFPA 13.
- R. Install access doors, minimum 20 inch by 30 inch, for access to inaccessible void, ceiling, and attic spaces. Coordinate locations with the A/E and show locations on Shop Drawings.
- S. Install flexible sprinkler connections with return bends for systems with hard pipe for risers and first elbow.
- T. Install air venting at high point for each wet pipe sprinkler system per NFPA 13. Include drain pipe and terminate over floor receptor.

### 3.06 FIRE DETECTION AND SYSTEM ACTUATION

- A. Coordinate with fire alarm system work in Division 28.
- B. Switches: Install water flow alarm switch for fire sprinkler systems. Install valve monitor (tamper) switches for valves.

### 3.07 ELECTRIC POWER FOR FIRE SUPPRESSION SYSTEMS

- A. Coordinate electrical power source required for work of this Section with Division 26.

- B. Where not shown on the electrical drawings, provide power wiring from electrical panel circuit breakers to devices requiring line voltage power. Similarly, provide low voltage wiring from alarm and supervisory devices to fire alarm system for final connections by fire alarm system subcontractors. Electrical interface shall be the responsibility of fire suppression system contractor.
- C. Where emergency power is included in the work or exists in building, extend electrical power source from that emergency power system.

### 3.08 FIELD QUALITY CONTROL

- A. Tests:
  - 1. Flush, test, and inspect fire suppression systems in accordance with NFPA 13, NFPA 24, and NFPA 25. No leakage permitted in piping. Prior to performing pressure test, notify the AHJs and the A/E of pressure test schedule.
  - 2. Test complete alarm system, including control and signal circuits:
    - a. Operate each signal initiating device.
    - b. Test operation of features of system under normal operation.
    - c. Test supervisory features of system.
- B. Notice: Give 1 week notice and arrange for field tests and inspections by the AHJs. Include paying for inspection fees and securing permits for same.
- C. Approval and Acceptance: After fire suppression systems have been completely installed, tested, and Substantial Completion review items corrected, obtain approval and acceptance of system by the AHJs in accordance with NFPA 13. Retests due to failure to meet design requirements shall be at no additional cost to the Owner. Submit completed Contractor's Material and Test Certificate using form in NFPA 13.

### 3.09 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Apply masking tape or paper cover to protect sprinkler heads, cover plates, and sprinkler escutcheons to protect from field painting. Remove after painting. Remove sprinkler heads having paint other than factory finish and provide new. Cleaning and reuse of painted sprinkler heads not acceptable.
- C. Protect sprinkler heads from damage until Substantial Completion.
- D. Fire suppression system subcontractor shall be responsible during installation and testing periods of sprinkler systems for any damage to work of others and to building and its contents caused by leaks in equipment, by unplugged or disconnected pipes, and fittings, and by overflow. Pay for necessary replacements or repairs to work of others damaged by such leakage.

### 3.10 FIRE SUPPRESSION SYSTEMS TRAINING

- A. Comply with requirements in Section 230810.

- B. Prior to date of Substantial Completion, instruct the Owner and their selected personnel in operation of fire suppression systems. Take special care to ensure that the Owner will:
1. Immediately recognize whether shutoff valves are open or closed position.
  2. Coordinate with the Owner to minimize damage that can occur when discharging system water.
  3. Know how to drain systems.
  4. Know how to test waterflow alarms and valve monitor (tamper) switches.
  5. Be familiar with contents of material included in the Operations and Maintenance Manual described in this Section.
  6. Review with the Owner frequencies of inspections and tests required by NFPA 25.

**3.11 COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

**3.12 SPRINKLER HEADS SCHEDULE**

Area/Ceiling	Head Type	Head Finish	Escutcheon Finish
Suspended or Hard Ceiling	Concealed Pendent	Satin Chrome	White
Areas without Suspended or Hard Ceilings	Upright	Satin Chrome	
Where Required	Sidewall	Satin Chrome	Satin Chrome

\*\*\*END OF SECTION\*\*\*

**SECTION 21 30 00  
FIRE PUMPS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes design and construction of fire pump systems.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Authorities Having Jurisdiction (AHJs):
  - 1. South King Fire & Rescue.
- C. Codes and Standards:
  - 1. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
  - 2. NFPA 13, Standard for the Installation of Sprinkler Systems.
  - 3. NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.
  - 4. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
  - 5. NFPA 72, National Fire Alarm Code.
  - 6. NFPA, Automatic Sprinkler System Handbook.
  - 7. Underwriters Laboratories Fire Protection Equipment Directory.
- D. Fire Pump System Contractor's Qualifications for Preparation of Shop Drawings, Installations, Inspections, Maintenance, and Servicing (WAC 212-80-043):
  - 1. Only licensed fire protection sprinkler system subcontractors shall execute contracts for installation, inspection, maintenance, or servicing of fire pump systems or any part of such system.
  - 2. Only licensed fire protection sprinkler contractors who have achieved at least State Level III licensure shall execute contracts for installation, inspection, testing, maintenance and/or servicing of NFPA 13 and all other systems per definition of fire protection sprinkler system or any part of such system in the State of Washington.
  - 3. Only those certificate of competency holders who have achieved at least State Level III certification shall supervise and/or certify preparation of layout drawings (Shop Drawings) installation, inspection, testing, maintenance, servicing of, or installation of NFPA 13, and all other systems per definition of fire protection sprinkler system in Chapter 18.160 RCW or any part thereof.

1.03 **SYSTEM DESIGN CRITERIA**

- A. Design, furnish, and install complete operable fire pump systems in accordance with the latest adopted editions of IBC, IFC, NFPA 13, NFPA 20, NFPA 24, NFPA 72, and applicable city, county, and state laws, codes, and standards. Include valves, flow switches, valve monitor switches, and accessories to meet requirements of the AHJs and aforementioned codes and standards.
- B. Coordination With Other Trades:
  - 1. Coordinate fire pump work with that of mechanical, sheet metal, plumbing, and electrical subcontractors so that best arrangement of equipment, piping, conduit, ducts, and similar items can be obtained.
  - 2. Identify points of conflict between this work and that of other trades so that conflict may be properly adjusted. Fire suppression system subcontractor shall remove and re-install work which interferes with work of other trades at no additional cost to the Owner.

1.04 **SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. The Contractor and the fire pump system subcontractor shall meet with the AHJs to review procedures for handling submittals, inspection, testing, and for general coordination.
- C. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Fire pump system.
  - 2. Piping specialties
- D. Shop Drawings and Calculations:
  - 1. Comply with requirements in NFPA 13 and NFPA 20. Do not submit final Shop Drawings to the A/E until approved by the AHJs.
  - 2. Submit Shop Drawings to the AHJs of fire pump system. Shop Drawings shall be complete floor plans showing new work including pipe sizes and cutting lengths, locations and types of hangers, valves, drain valves, and other related items.
  - 3. Following review and approval by the AHJs, submit the Shop Drawings to the A/E. Do not proceed with installation until Shop Drawings have been approved by the A/E.
  - 4. Indicate location of alarm and supervisory initiating devices, electrical connections, and other electrical equipment associated with fire pump system.
- E. Obtain from each AHJ written certification that permanent installation has been inspected and that it complies with the AHJs' published regulations and requirements. Submit prior to Substantial Completion.
- F. Operations and Maintenance Data:
  - 1. Prepare complete, simple, understandable, step-by-step, testing instructions with recommended and required testing frequency of equipment with methods for testing equipment. Include trouble-shooting manual.



2. Prepare complete, easy-to-read, understandable maintenance instructions including the following information:
    - a. Instruction on replacing components of system including internal parts.
    - b. List of equipment and components with address and phone number of both manufacturer and local supplier of each item.
  3. Include fire pump system pressure and alarm system test.
  4. Include copies of NFPA 25.
  5. Submit one week minimum prior to system training.
- G. Record Drawings:
1. Provide in accordance with Division 01 and Section 230500.
  2. Submit one week minimum prior to system training.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Manufacturer of equipment regularly engaged in the manufacture of components specified and with published catalogs listing pertinent specifications of items manufactured.
- B. Manufacturers name and model identification used throughout this Section are to establish general configuration, function, size, performance and quality.
- C. Manufacturers: Peerless Pump Company, FAIRBANKS NIJHUIS®, Aurora Pump, Armstrong Fluid Technology, or approved.

### 2.02 GENERAL

- A. Equipment, Material, and Components Required by NFPA to be listed: Listed in UL Fire Protection Equipment Directory or approved by FM and the AHJs.

### 2.03 FIRE PUMP SYSTEM

- A. General: Complete fire pump system to include primary pump, jockey pump, drivers, controllers, and accessories in accordance with NFPA 20. System components furnished under a single subcontract with pump manufacturer's firm or factory-authorized representative. System mounted on fabricated steel base with necessary components such that only piping and power wiring to and from system is required. Pipes, piping components, and pressure sensing lines anchored to steel base by means of structural steel supports. Entire package system hydrostatically tested at factory prior to shipment.
- B. Operating Conditions:
  1. Capacities, suction conditions, driver characteristics as indicated in the Contract Documents.
  2. Pump rated to deliver not less than 150 percent of rated capacity at 65 percent of rated head with maximum head not to exceed 120 percent of rated head.
  3. Pump Suction Lift Capacity: 15 feet at 150 percent capacity rating point.
  4. Suction pressure at 150 percent of rated capacity.

- C. Primary Pump: Vertical In-Line with Class 30 cast iron casing, Teflon lantern ring, bronze impeller, packing glands and shaft sleeve. 125 pound standard ANSI flanges. Pump and motor mounted on common baseplate of cast iron or steel and directly connected through flexible coupling. Metal guard over coupling.
- D. Drive: Electric motor. Size not to exceed permissible loading limited of NFPA 20. Locked rotor current not to exceed values allowed in NFPA 20.
- E. Fire Pump Fittings and Accessories:
1. 3-1/2 inch compound suction gage.
  2. 3-1/2 inch discharge pressure gage.
  3. 1/2 inch automatic air release valve.
  4. 3/4 inch minimum casing relief valve.
  5. Isolation valve at fire pump suction.
  6. Eccentric suction reducer in accordance with NFPA 20.
  7. Concentric discharge increaser in accordance with NFPA 20.
  8. Discharge check valve.
  9. Isolation at fire pump discharge.
  10. Base elbow.
  11. Water flow meter and sensor.
  12. Test header manifold, ductile iron or brass body for hose valves. Include nozzle outlets arranged in single line. Horizontal, flush-wall mounting rectangular attachment, polished brass finish escutcheon plate labeled PUMP TEST CONNECTION.
  13. Hose valves, UL 668, straightway pattern, and bronze with cap and chain. Include hose thread that complies with local fire department standards and finish same as for test header manifold escutcheon plate.
- F. Controller:
1. General: Automatic controller to start primary pump motor on drop in system pressure. UL listed and labeled. Equipment mounted within dripproof, moisture resistant, wall or floor mounted NEMA 2 enclosure labeled FIRE PUMP CONTROLLER. Unit furnished packaged by fire pump supplier and completely assembled, wired, and factory tested.
  2. Controller Components, Accessories, Function:
    - a. Isolation switch externally operable, quick break type, with provision for locking in open position.
    - b. Motor starter contactor(s).
    - c. Soft starter, operated automatically through pressure switch or manually by emergency start handle. Include latching hook for emergency switch.
    - d. Magnetic only circuit breaker with current limiters with short circuit interrupting rating of 25,000 A.I.C.
    - e. Pressure switch set to cut in and out at adjustable settings.
    - f. Run period timer set in accordance with NFPA 20. Automatic stop.
    - g. Control transformer.
    - h. Drop-out type control relays.
    - i. Power availability pilot light and relays with contacts to remote signal for loss of line power in any phase, control transformer failure, and disconnection.
    - j. Hand-off-auto selector switch.
    - k. Ammeter test link and voltmeter test.

- l. Contacts for remote alarm and signal for controller and pump run condition, and loss of alarm panel.
  - m. Auxiliary contacts on starter, 1 normally open, 1 normally closed.
  - n. Floor stand.
  - o. Top drip hood.
  - p. Alarm panel with visual signals and audible alarms to supervise status of pump controller. Monitor primary pump controller in pump run condition, loss of line power to controller in any phase, phase reversal, failure or disconnection of control transformer in controller, loss of separate supervisory power supply to alarm panel, alarm silence pushbutton, and hand-off-auto switch in "OFF" position.
  - q. Include means on controller to operate alarm signal continuously while pump is running.
  - r. Automatic starting and stopping of jockey pump through pressure switch to maintain primary pump system pressure.
- G. Transfer Switch:
- 1. General: Automatic transfer switch to connect fire pump to either building power or generator power. UL listed and labeled and FM approved. Equipment mounted within drip-proof, moisture resistant, wall or floor mounted NEMA 2 enclosure labeled "FIRE PUMP TRANSFER SWITCH". Unit furnished packaged by fire pump supplier and completely assembled, wired, and factory tested.
  - 2. Transfer Switch, Accessories, Function:
    - a. Isolation switch externally operable, quick break type, with provision for locking in open position.
    - b. Circuit breaker overcurrent sensor solid state microprocessor type internal to circuit breaker.
    - c. Externally mounted pilot light to indicate controller primary power is available.
    - d. Solid state running period timer to keep motor running when started automatically per NFPA 20.
    - e. Controller circuit transformer heavy duty type with minimum rating of 150 VA without integral overcurrent protection.
    - f. Dry alarm contacts for remote alarm of pump running, controller power available, and phase reversal.
    - g. Controller power monitored by three-phase power monitor.
    - h. Circuit for remote starting of controller requiring only contact closure to initiate.
- H. Jockey Pump:
- 1. Centrifugal or turbine type with cast iron casing, bronze impellor, stainless steel shaft, and mechanical seal.
  - 2. TEFC motor.
  - 3. Cut-in pressure 10 psi above primary fire pump rated pressure. Operate until pressure returns to 20 to 25 psi above primary pressure.
  - 4. Factory-mounted relief valve.
- I. Jockey Pump Fittings and Accessories:
- 1. Isolation valve at jockey pump suction.

2. Isolation valve at jockey pump discharge.
3. Discharge check valve.

J. Jockey Pump Controller:

1. UL listed and labeled and FM approved.
2. Equipment mounted in NEMA 2 enclosure.
3. Suitable for operation with fire pump control system.
4. Hand-off-auto switch on door with indicating lights.
5. Fusible disconnect switch with dual element fuses.
6. Magnetic starter with 3-phase overload and underload protection.
7. Automatic start characteristics responsive to water pressure by means of adjustable pressure switch.
8. Adjustable running period timer.
9. Control transformer to 120 V.

**2.04 BUILDING FIRE ALARM SYSTEM INTERFACE**

- A. Coordinate with work specified in Division 28.

**2.05 PIPING SPECIALTIES**

- A. Pipe Supports: Include metal pipe supports, clamps, and other pipe support items in accordance with requirements in NFPA 13. Seismically design pipe and equipment hangers and braces per IBC, ASCE 7, and NFPA 13.
- B. Identification Signs: Enameled signs for drain valves, test valves, control valves, and alarm valves indicating their use.
- C. Miscellaneous Connections and Fittings: Drain valves, flushing connections, discharge outlets, and other items in accordance with requirements in NFPA 13 and NFPA 20.
- D. Pipe, Fittings, Valves, and Valve Monitor (Tamper) Switches: Comply with requirements in Section 211000.

**PART 3 - EXECUTION**

**3.01 INSPECTION**

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Cooperate with other trades to ensure adequate space for piping placement.
- C. Review Drawings, Specifications, and the Shop Drawings of other trades to coordinate work and minimize unnecessary offsets and revisions to approved Shop Drawings. Failure to coordinate does not relieve pump system subcontractor from meeting performance standards specified in this Section.
- D. Do not order, fabricate, or install materials until approvals are received from the AHJ.
- E. Install material in strict accordance with the Shop Drawings approved by the AHJs and reviewed by the A/E.
- F. Service Interruptions: Comply with requirements of Section 230500. Obtain advance approval from the Owner and local fire department.

**3.04 FIRE PUMP AND PIPING INSTALLATION**

- A. Install fire pump, jockey pump, controllers, transfer switch, pipe and fittings, and accessories according to NFPA 20.
- B. Primary Pump: Anchor bolt to housekeeping pad. Fill baseplate with grout.
- C. Support piping only from structural members and not from work of other trades. Hanging pipes from ducts and equipment not acceptable.
- D. Install piping system braced to withstand damage from earthquakes. Install earthquake bracing in accordance with IBC, ASCE 7, and NFPA 13.
- E. Install system and auxiliary drains to discharge to paved areas, concrete splash blocks, suitable waste within building, or to other locations as indicated or required by the A/E. Exterior drain locations shall be approved by the A/E. Install drain outlets on the building exterior between 6 and 18 inch above finished grade. Direct connection to sewer systems not acceptable. Install drain valves at interior walls maximum 5 feet above finished floor, grating, and maintenance access area. Do not install drain valves on outside of building. Install dirt legs and drain valves at low points of piping to permit complete drainage of system without disconnection of any piping.
- F. Install test header manifold on exterior wall of building as indicated on the Drawings.
- G. Identification Signs: Install with chain on stem of valves. Comply with requirements in NFPA 13.

**3.05 FIRE DETECTION AND SYSTEM ACTUATION**

- A. Coordinate with fire alarm system work in Division 28.
- B. Switches: Install valve monitor (tamper) switches for valves.

**3.06 ELECTRIC POWER FOR FIRE PUMPS SYSTEMS**

- A. Coordinate electrical power source required for work of this Section with Division 26.
- B. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical installer.
- C. Where not shown on the electrical drawings, provide power wiring from electrical panel circuit breakers to devices requiring line voltage power. Similarly, provide low voltage wiring from alarm and signal devices to fire alarm system for final connections by the fire alarm system subcontractors.
- D. Where emergency power is included in the work or exists in building, extend electrical power source from that emergency power system.

**3.07 FIELD QUALITY CONTROL**

- A. Flush, test, and inspect fire pump systems according to NFPA 13 and NFPA 20.
- B. Tests:
  - 1. Test piping in accordance with NFPA 13 and NFPA 20. No leakage permitted in piping. Prior to performing pressure test, notify the AHJs and the A/E of pressure test schedule.
  - 2. Test complete alarm system, including control and signal circuits:
    - a. Operate each signal initiating device.
    - b. Test operation of features of system under normal operation.
    - c. Test supervisory features of system.
- C. Notice: Give 1 week notice and arrange for field tests and inspections by the AHJ, including paying for inspection fees and securing permits for same.
- D. Approval and Acceptance: After fire pump system has been completely installed, tested, and substantial completion review items corrected, obtain approval and acceptance of system by the AHJs in accordance with NFPA 13 and NFPA 20. Retests due to failure to meet design requirements shall be at no additional cost to the Owner. Submit written Contractor's Material and Test Certificate using form in NFPA 13.
- E. Fire Pump System:
  - 1. Manufacturer's Field Service: Engage factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including primary pump and jockey pump units, piping, and electrical connections. Report results in writing.
    - a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    - b. Check suction line connections for tightness so no air gets into pumps.
    - c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, provide new units, and retest.

- d. Test and adjust controls and safeties. Remove damaged and malfunctioning controls and equipment and provide new devices.
  - e. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of primary pump test water. Fire hoses are for field-acceptance tests only and are not property of the Owner.
  - f. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:
    - 1) Lubricate oil-lubrication type bearings.
    - 2) Remove grease-lubrication type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
    - 3) Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
    - 4) Following final alignment of primary pump and motor, verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.
  - g. Starting procedure for pumps as follows:
    - 1) Prime primary pump by opening suction valve, closing drains, and prepare primary pump for operation.
    - 2) Open sealing liquid supply valves if primary pump is so fitted.
    - 3) Start motor.
    - 4) Open discharge valve slowly.
    - 5) Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately but let packing run in before reducing leakage through stuffing boxes.
    - 6) Check general mechanical operation of pump and motor.
2. Perform field tests for each fire pump system piping when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment. Retest to demonstrate compliance. Remove equipment that cannot be satisfactorily corrected or that does not perform properly, provide new, and retest to demonstrate compliance. Verify that each fire pump system performs as indicated in the Contract Drawings. Report test results in writing.

### 3.08 CLEANING AND PROTECTION

- A. Protect fire pump system from damage until Substantial Completion.
- B. Fire pump system subcontractor shall be responsible during installation and testing periods of system for any damage to work of others and to building and its contents caused by leaks in equipment, by unplugged or disconnected pipes, fittings or by overflow, and shall pay for necessary replacements or repairs to work of others damaged by such leakage.

### 3.09 FIRE SUPPRESSION SYSTEMS TRAINING

- A. Comply with requirements in Section 230810.

- B. Prior to date of beneficial occupancy, instruct the Owner and their selected personnel in operation of fire pump system. Take special care to ensure that the Owner will:
1. Immediately recognize whether shutoff valves are open or closed position.
  2. Know how to drain systems.
  3. Know how to test waterflow alarms and valve monitor switches.
  4. Be familiar with contents of material included in the Operations and Maintenance Manual described in this Section, including requirements of NFPA 25.
- C. As soon as practical after startup, engage factory authorized service representative to conduct separate session to demonstrate that equipment operates as indicated in the Contract Documents and in accordance with manufacturer's recommendations. Perform demonstrations in presence of the Owner and the A/E. Give minimum 1 week notice prior to demonstration. Furnish instruments and personnel required to conduct demonstration.
- D. Demonstrate proper performance of operating and safety controls, as well as stable equipment performance over entire operating range to satisfaction of the Owner and the A/E prior to final acceptance.
- E. Include instruction session to identify locations of servicing points and required maintenance requirements to the Owner's personnel.
- F. Include preliminary discussion and presentation of information from instruction manuals, with appropriate references to the Contract Documents, followed by tour explaining maintenance requirements, access methods, servicing and maintenance procedures, equipment cleaning procedures, control settings, and available adjustments.
- G. Assure that the Owner is familiar with the existence and contents of material included in the Operations and Maintenance Manual described in this Section, including requirements of NFPA 25.

### 3.10 COMMISSIONING

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*



**SECTION 22 00 00  
PLUMBING WORK SPECIFIED IN DIVISION 23**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

A. Description: The following Sections apply to the Work in this Division with exception of items specifically described in Division 22:

- |     |                |  |
|-----|----------------|--|
| 1.  | Section 230500 | General Provisions                         |
| 2.  | Section 230505 | Project Closeout and System Start-Up       |
| 3.  | Section 230510 | Basic Materials and Methods                |
| 4.  | Section 230513 | Electrical Provisions for Mechanical Work  |
| 5.  | Section 230548 | Vibration Isolation                        |
| 6.  | Section 230550 | Seismic Control                            |
| 7.  | Section 230593 | Testing, Adjusting, and Balancing          |
| 8.  | Section 230700 | Mechanical Insulation                      |
| 9.  | Section 230800 | Mechanical Systems Commissioning           |
| 10. | Section 230810 | Systems Training                           |
| 11. | Section 230820 | Systems Operations and Maintenance Manuals |
| 12. | Section 232116 | Piping Specialties                         |

**PART 2 - PRODUCTS**

Not used.

**PART 3 - EXECUTION**

Not used.

\*\*\*END OF SECTION\*\*\*

**SECTION 22 11 16  
DOMESTIC WATER SYSTEM**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes domestic water piping for potable and non-potable systems and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Applicable plumbing code pertaining to materials, products, and installation of domestic water piping.
  - 2. ASHRAE Standard 188, Legionellosis: Risk Management for Building Water Systems.
  - 3. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - 4. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - 5. ASME B31.1, Power Piping.
  - 6. ASME B31.9, Building Services Piping.
  - 7. ASSE 1001, Performance Requirements for Atmospheric Type Vacuum Breakers.
  - 8. ASSE 1010, Performance Requirements for Water Hammer Arrestors.
  - 9. ASSE 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.
  - 10. ASSE 1044, Performance Requirements for Trap Seal Primer Devices-Drainage Types and Electronic Design Types.
  - 11. ASTM A 536, Standard Specification for Ductile Iron Castings.
  - 12. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
  - 13. ASTM B 32, Standard Specification for Solder Material.
  - 14. ASTM B 75, Standard Specification for Seamless Copper Tube.
  - 15. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
  - 16. ASTM B 813, Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
  - 17. ASTM B 828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
  - 18. AWS A5.8, Specification for Brazing Filler Metal.
  - 19. AWWA C 104/A 21.4, Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water.
  - 20. AWWA C 110/A 21.10, Standard for Ductile-Iron and Gray Fittings for Water.
  - 21. AWWA C 111/A 21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - 22. AWWA C 151/A 21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.

23. AWWA C 153/A21.53, Standard for Ductile-Iron Pipe Compact Fittings for Water Service.
  24. AWWA C651, Disinfecting Water Mains.
  25. AWWA C652, Disinfection of Water Storage Facilities.
  26. NFPA 13, Standard for the Installation of Sprinkler Systems.
  27. NSF 61, Drinking Water Systems Components – Health Effects.
  28. NSF 372, Drinking Water Systems Components – Lead Content.
  29. PDI-WH 201, Water Hammer Arrestors.
- C. Installer's Qualifications for Copper Press Fitting Couplings: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- D. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI credited, third party certification organization to requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.

### 1.03 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
1. Copper tubing including solder and flux.
  2. Ductile iron.
  3. Dielectric unions.
  4. Pre-Insulated, Underground, Direct Buried Hot Plumbing Piping
  5. Backflow preventers.
  6. Y-type strainers
  7. Basket strainers.
  8. Water meters.
  9. Trap primers.
  10. Water hammer arresters.
  11. Blank copy of start-up and test report form.
- C. Shop Drawings:
1. Comply with requirements in Section 230500 regarding 2D Shop Drawings.
  2. Pre-Insulated, Underground, Direct Buried Hot Plumbing Piping
- D. Installer Qualification Data for Copper Press Fitting Couplings.
- E. Certificates:
1. Certificates of Inspection by Authorities Having Jurisdiction (AHJ)
  2. Certificates of Satisfactory Bacteriological Test. Include copy in the Operations and Maintenance Manual.
  3. Certificates of flushing and sterilization with approval by the AHJ.
  4. Certification to NSF 61 and NSF 372 for no-lead/low lead products.
  5. Certificates of installers for copper press fittings.

- F. List of names of installers trained by pre-insulated, underground, direct buried hot plumbing pipe system manufacturer in installation of system. Only those named on list will be allowed to install system. List shall not be more than 1 year old.
- G. Test Reports:
  - 1. Field test reports.
  - 2. Site visit reports.
  - 3. Submit completed copy of reports and certificates and include copy in the Operations and Maintenance Manual.

**1.04 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION**

- A. Section 230900 – Automatic Temperature Controls: Thermal wells, flow switches, and similar components.

**PART 2 - PRODUCTS**

**2.01 GENERAL**

- A. Furnish products of sizes, ratings, and characteristics indicated, which comply with manufacturer's standard materials, design, and construction in accordance with published product information. Furnish quantity of piping and appurtenances required for complete installation.
- B. Pressure Ratings: Provide components with minimum pressure rating of 125 psig working pressure.

**2.02 MANUFACTURERS**

- A. Copper Tubing: Cerro, Mueller, Wolverine
- B. Copper Tube Fittings: NIBCO®, Mueller, Elkhart.
- C. Gaskets: Crane, Garlock, U. S. Rubber, Anchor, Flexitallic. Rubber, plastic, and silicone gaskets not acceptable for domestic hot water systems.

**2.03 COPPER TUBING**

- A. General: Copper tubing only. Sweat, press fittings, or flanged, only. CPVC and PP-R and PP-RCT acceptable.
- B. Above Ground: Type L copper water tube, hard-drawn, ASTM B 88.
- C. Underground: Type K copper water tube, soft-drawn, ASTM B 88.
- D. Tubing, Flexible: Soft copper tubing, flexible stainless steel hose, or approved. Rated for design working pressure of application.
- E. Fittings: Wrought copper fittings and screwed adapters for soldered and brazed joints, ASME B16.22. Cast bronze fittings and screwed adapters for soldered and brazed joints, ASME B16.18.

- F. Copper Press Fitting Couplings and Fittings:
  - 1. Suitable for Types K and L hard drawn copper tubing for sizes 1/2 through 4 inch and soft drawn copper tubing for sizes 1/2 through 1-1/4 inch. Press-to-connect joint made with pressing tool and jaw sets recommended by fitting manufacturer. NIBCO® Press System™, Viega ProPress System, or Aalberts Industries ApolloPress®.
  - 2. Approved by NSF International, IAPMO, UL and compliant with UPC and NFPA 13.
  - 3. Wrought copper fittings per ASTM B 75 conforming to ASME B16.18 or ASME B16.22. Rated to maximum 200 psig non-shock working pressure for temperature range between minus 20 F to 250 F.
- G. Unions: Wrought copper solder joint unions, ASME B16.22; cast bronze solder joint fittings, ASME B16.18.
- H. Flanges and Flanged Fittings: Cast bronze, 125 pound Class, ASME Standards.
- I. Gaskets: 1/16 inch thick compressed non-asbestos material selected for applicable temperature and pressure of systems installed. Full face gaskets for flat faced flanges.
- J. Joint Compound: Teflon tape.
- K. Solder Material: 95 percent tin, 5 percent antimony solder or 96 percent tin 4 percent silver conforming to ASTM B 32 and NSF 61. Lead free (not more than 0.2 percent lead). Flux water soluble conforming to ASTM B 813. J.W. Harris "Bridgit", Rectorseal, Oatey, Superior Flux, Worthington Cylinders, BerzOmatic, or approved.
- L. Brazing Material: Copper-phosphorus alloys, BcuP Series, conforming to AWS A5.8. Lead free (not more than 0.2 percent lead) conforming to ASTM B 32 and NSF 61. Flux water soluble conforming to ASTM B 813. Rectorseal, Oatey, Superior Flux, or approved.

#### 2.04 DUCTILE IRON

- A. 3 Inch and Larger, Outside Building (Buried) and Underground, Inside Building: Cement-lined. Joints with gaskets and restraining rod ties. AWWA C 104, AWWA C 110, AWWA C 111, AWWA C 151, and AWWA C 153.

#### 2.05 DIELECTRIC UNIONS

- A. Union Style: Grooved, threaded, or plain end, ASTM F 1545. Capital Series CS; Epco Dielectric Unions, PPP Clearflow® Dielectric Waterway, or Victaulic Clearflow Dielectric Waterway.
- B. Flange for 2 1/2 Inch and Larger: ASTM F 1545, insulating flange union per companion, 1/2 flange union with bolt insulators, dielectric gasket, bolts and nuts. Capital Series F, Epco, or Victaulic Clearflow Dielectric Waterway.
- C. Ratings: Select temperature and pressure applicable for the systems in which they are installed.

#### 2.06 PRE-INSULATED, UNDERGROUND, DIRECT BURIED HOT PLUMBING PIPING

- A. Description: Factory fabricated and hydrostatically tested integral sealed units of HDPE outer jacket, copper tubing carrier pipe, with insulation completely filling annular space between pipe and jacket. Jacket ends protected with factory applied moisture barrier.

- B. System Design: Piping system manufacturer shall design systems to accommodate thermal expansion and thrusts associated with the fluid used. Anchors and expansion provisions shown on the Drawings are for guidance only. Initial fluid temperature 40 F with 140F operating temperature.
- C. Outer Jacket: Outer jacket high-density polyethylene (HDPE), minimum 0.125 inch thickness for jacket diameter up to 12 inch, 0.150 inch thickness for jacket diameter up to 20 inch, and 0.175 inch thickness for larger than 20 inch.
- D. Insulation: Polyurethane foam, factory spray applied for straight Sections and poured in place for piping joints with the following minimum properties: Minimum 1-1/2 inch nominal thickness. Two pounds per cubic foot density, 90 to 95 percent closed cell content, initial thermal conductivity 0.16 Btu/hr/sq ft/inch/F at 75 F. Insulation thickness per manufacturer's recommendations to completely fill space between carrier pipe and jacket with foam. Fittings for copper tubing field insulated with material furnished by piping system manufacturer.
- E. Carrier Pipe: Type L copper tubing conforming to ASTM B 88 with brazed joints for all sizes. Piping material selected such that dissimilar metals at joints will not occur.
- F. Field Joints Closures: HDPE heat shrink sleeves for field joints and heat shrink tape for field insulated fittings.
- G. Leak Detection System for Carrier Pipe: Copper wire factory installed in insulation, continuous. Include alarm panel with connections to DDC system specified in Section 230900.
- H. Accessories: Couplings and fittings, including elbows, tees, field closures, rock shields, end caps, and wall and floor penetrations compatible with carrier piping and shipped loose by system supplier.
- I. Manufacturers: Thermal Pipe Systems, Inc., Thermacor Process Inc., Perma-Pipe, Rovanco, or approved.

## 2.07 BACKFLOW PREVENTERS

- A. Reduced Pressure Principle Backflow Assembly (RPZ): ASSE 1013, 175 psig working pressure, bronze body and working parts for 2 inch and smaller and cast iron body for 2-1/2 inch and larger, stainless steel springs, with drain funnel. Lead free. Include ball valves for 2 inch size and smaller and outside screw and yoke gate valves for 2-1/2 inch and larger on inlet and outlet, strainer on inlet, test cocks, and relief valve.
- B. Manufacturers: As listed in "Backflow Prevention Assemblies Approved for Installation in Washington State."

## 2.08 Y-TYPE STRAINERS

- A. Description: Line size of connecting piping with ends matching piping system materials. Select strainers for minimum 125 psi working pressure. Include ASTM A 666 Type 304 stainless steel screens, unless specified otherwise, with 3/64 inch perforations at 233 per sq. in. and blowout connection with ball valve and capped nipple or gate valve with plug.
  - 1. Threaded or Solder Ends, 2 Inch and Smaller for Copper Pipe: Cast bronze body with brass screen.

2. Flanged Ends, 2-1/2 Inch and Larger: Cast-iron body.
3. FDA approved epoxy coating on interior and exterior surfaces.
4. Manufacturers: Armstrong Fluid Technology, Watts®, Crane, Hoffman Specialty®, Victaulic Co. Metraflex, Spirax Sarco, Nibco, or approved.

#### 2.09 BASKET STRAINERS

- A. Description: Cast iron body with bolted cover, flanged connections, and drain plug. Select strainer for 125 psi working pressure. Include Type 304 stainless steel screen with 3/64 inch perforations for 2 and 3 inch sizes and 1/8 inch perforations for 4 inch and larger sizes. Interior of body with FDA approved epoxy coating.
- B. Manufacturers: Watts No. 97FB-CI, Spirax Sarco, Metraflex, or approved.

#### 2.10 TRAP PRIMERS

- A. Electronic Type: Factory assembled unit with electronic module, 24 V transformer, solenoid valve, and integrated strainer, ball valve, brass atmospheric vacuum breaker, multiport distribution manifold, and interconnecting piping. Assembly mounted in a galvanized steel enclosure with cover for recessed installation. ASSE 1044. Zurn Z1020, Precision Plumbing Products (P.P.P.), or approved.

#### 2.11 PIPING SPECIALTIES

- A. Pipe Sleeves: Comply with requirements in Section 230510.
- B. Pipe Hangers and Supports: Comply with requirements in Section 232116.
- C. Thermometers and Pressure Gages: Comply with requirements in Section 232116.
- D. Pipe Escutcheons: Comply with requirements in Section 232116.
- E. Y-Type Strainers: Comply with requirements in Section 232116.
- F. Water Hammer Arresters: Factory-sealed shock arresters with direct action bellows, rated in accordance with Plumbing Drainage Institute Standard P.D.I. WH-201 Standard or ASSE 1010. Jay R. Smith, Hydrotrol, Josam, Zurn, PPP or approved.
- G. Non-Potable Water Signage:
  1. Comply with requirements of UPC for non-potable water piping systems and fixtures.
  2. Signage shall state: "CAUTION: NON-POTABLE WATER. DO NOT DRINK".
  3. Obtain approval of signage shape, size, and location from the AHJ prior to installation.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

**3.04 PIPING INSTALLATION**

- A. General:
  - 1. Install piping, fittings, and appurtenances in accordance with recognized industry practices which will achieve permanently leakproof piping systems and capable of performing each indicated service without piping failure.
  - 2. Install each run with minimum joints and couplings, but with adequate and accessible unions or flanges for disassembly and maintenance replacement of valves and equipment.
  - 3. Reduce sizes (where indicated) by use of reducing fittings. Bushings not acceptable.
  - 4. Seal pipe penetrations through walls and floors with resilient sealant specified in Section 230548.
- B. Align piping accurately at connections, with 1/16 inch misalignment tolerance.
- C. Install pipe generally sloped to permit drainage at low points, free from sags, bends, and traps, and in a manner to conserve space for other work. Refer to other Sections for specific installation requirements.
- D. Location of Piping:
  - 1. Piping plans, Sections, details, and diagrams are diagrammatic indicating general arrangement of piping installation. Locate piping and include offsets to avoid interference with building structural members, equipment, building openings, light fixtures, ductwork, electrical work, and other obstructions.
  - 2. Arrange piping to allow access for operation, service, disconnection, and removal and replacement of valves, fixtures, and equipment.
  - 3. In general, maintain the maximum possible headroom in ways of egress, including pedestrian walkways and maintenance aisles, minimum headroom of 6'-8" from floor to bottom of any component.



4. Within buildings, conceal piping in walls and chases and above ceilings except where indicated in the Contract Documents to remain exposed. Do not cover or enclose work until completely inspected and approved by the AHJ. Should Work be covered or enclosed prior to inspections and approvals, uncover work as directed by the A/E. After Work has been inspected and approved by the AHJ, make repairs and replacements with materials as necessary to obtain approval of the A/E at no additional cost to the Owner.
  5. Route piping parallel to column lines and perpendicular to floor unless indicated otherwise.
- E. Flexible Tubing: Install in sleeves below concrete slabs on grade for routing of services to kitchen and laboratory island fixtures and remote equipment.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install fittings for changes in direction and branch connections. Install concrete thrust blocks and restraining rods for ductile iron fittings.
- H. Install piping to allow application of insulation.
- I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- J. Clean interior of piping before making joints. Maintain cleanliness of piping throughout installation. Install caps or plugs on open ends of cleaned piping.
- K. Install pipe supports in accordance with MSS SP-69 and Section 232116, whichever is more stringent.
- L. Install hot and cold water piping runouts to fixtures of sizes indicated but in no case smaller than required by applicable plumbing code. Limit dead legs to maximum 5 pipe diameters. Connect hot water circulating system within 5 feet of fixture and bank of fixtures or as indicated on the Drawings.
- M. Install isolation valves at major toilet groups and as indicated on the Drawings.
- N. Install balancing valves specified in Section 221120 on domestic hot water hot water recirculating systems at branch connections to mains.
- O. Water Hammer Arresters:
1. Install in accordance with Plumbing Drainage Institute Standard P.D.I. WH-201 or ASSE 1010 recommendations. Install at ends of hot and cold water pipes serving 2 or more fixtures and at solenoid valves, dishwashers, clothes washers, and other equipment having quick closing valves. Install with shutoff valve on inlet to water hammer arrester.
  2. Furnish and install access doors as specified in Section 230510 where water hammer arresters are concealed within or above general construction. Group multiple water hammer arresters to be accessible through a common access door.
- P. Install non-potable water signage.
- Q. Install vacuum relief valve on cold water piping to bottom-feed water heaters.

**3.05 SOLDERED AND BRAZED JOINTS**

- A. Comply with applicable provisions of ASTM B 828 or “Copper Tube Handbook” by CDA for soldered joints and “Brazing Handbook” by AWS for brazed joints.
- B. Cut ends square and remove fins and burrs. Replace dents and damaged tubing with new tubing.
- C. Remove grease and oil from joints by wiping with clean cloth saturated with suitable chemical solvent. Clean with emery cloth.
- D. After cleaning, apply non-corrosive flux, apply heat and material and hold joint rigidly until hardened.
- E. Wipe excess material from exterior of joint before hardening.
- F. Before soldering and brazing, remove stems and washers of valves.
- G. Braze 2-1/2 inch and larger piping unless copper press fitting couplings are used.

**3.06 COPPER PRESS FITTING COUPLINGS**

- A. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

**3.07 FLANGED JOINTS**

- A. Match flanges within piping system, and at connections with valves and equipment.
- B. Clean flange faces and install gaskets concentrically positioned.
- C. Use suitable lubricants on bolt threads and tighten bolts to provide uniform compression of gaskets.

**3.08 DIELECTRIC UNIONS**

- A. Install at the Following Locations:
  - 1. At black piping connections to copper tubing.
  - 2. At black steel piping connections to bronze valves and similar devices.

**3.09 PRE-INSULATED, UNDERGROUND, DIRECT BURIED HOT PLUMBING PIPING**

- A. Excavation, Bedding Material, Backfill and Compaction: Comply with manufacturer’s installation instructions for thickness and type of bedding and backfill material and with requirements of Section 230510.
- B. Pipe Tape: Install continuous 2 inch wide strip pipe tape marker in trench 6 inch below finish grade above each pipe. Yellow color with system identification in black letters.
- C. Piping: Install in accordance with manufacturer’s installation instructions and approved Shop Drawings.

- D. Expansion Loops, L and Z Bends: Factory fabricated thermal expansion compensation using expansion elbows identical to straight pipe Sections. Install with flexible elastomeric expansion pads at changes in direction, per piping system manufacturer's instructions.
- E. Manufacturer's Services: Provide services of an authorized and factory trained service agency to be on-site for the following:
  - 1. Instruct installers in installation procedures to ensure that system is installed per piping system manufacturer's instructions and the Contract Documents.
  - 2. Inspection and unloading of pipe materials.
  - 3. Train installers as to field joints, insulation, and anchor requirements.
  - 4. Render advice during the installation of pipe.
  - 5. Inspection of anchors, expansion loops, and bends.
  - 6. Inspect piping before backfilling.
  - 7. Prepare and issue reports to the A/E identifying work observed.

### 3.10 MECHANICAL EQUIPMENT CONNECTIONS

- A. Connect hot and cold water piping to mechanical equipment as indicated on the Drawings. Comply with equipment manufacturer's installation instructions. Install shutoff valve and union for each connection and drain valve on drain connection. Locate unions to allow removal of equipment without piping disassembly beyond union.

### 3.11 BACKFLOW PREVENTERS

- A. Install in accordance with "Backflow Prevention assemblies Approved for Installation in Washington State". Install maximum 5 feet above finished floor.
- B. Route drain from funnel drain to nearest floor receptor, mop sink, or other approved point of termination. Avoid running pipe across walkways.

### 3.12 CLEANING AND INSPECTING

- A. Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).
- B. Inspect each run of each system for completion of joints, supports, and accessory items.
- C. Inspect pressure piping in accordance with procedures of ASME B31.1 and ASME B31.9

### 3.13 PRESSURE TESTING

- A. Provide equipment and apparatus necessary for tests. Make tests in presence of the A/E. Notify the A/E at least 48 hours before expected tests.
- B. Test piping systems before insulation has been applied, and before backfilling.
- C. Test Pressures and Duration: Test piping systems at pressure of 1-1/2 times design working pressure or at 100 psig, whichever is greater. Maintain test pressure for sufficient time to permit complete inspection of system under test. Minimum 2 hour duration. Test in Sections and test entire system when completely installed.

- D. Test Procedure:
1. Before tests, remove or valve off from the system gages, traps, pressure reducing valves, pumps, and other apparatus which may be damaged by test pressure.
  2. Install calibrated test pressure gage in system to observe any loss in pressure.
  3. Test piping at metal temperature greater than 35 F.
  4. Open vents, and other connections which can serve as vents, during filling so that air is vented prior to applying test pressure to system.
- E. Testing Media Requirements:
1. Use clean, fresh city water for hydrostatic testing. Water temperature shall be not less than 60 F and not greater than 100 F.
  2. Drain water immediately after hydrostatic testing. Vent system while draining to avoid creating a vacuum.
- F. Test Repairs:
1. Remove materials such as gaskets and bolts damaged during tests and flushing and provide new components.
  2. Use new gaskets each time a flanged joint is made up.
  3. Repair defects which develop during testing and retest piping systems until they show no defect or weakness and are tight. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- G. Test Records: Make and submit records for each piping installation. Include copies in the Operations and Maintenance Manual. Include at a minimum, the following items:
1. Date of test.
  2. Description and identification of piping tested.
  3. Test fluid.
  4. Test pressure.
  5. Test duration.
  6. Remarks to include such items as: Leaks (type, location); repairs made on leaks.
  7. Signature and date of person witnessing the test.
  8. Certification by the Contractor.
- H. Systems Which Connect to Existing Piping: Isolate new piping system from existing system by the closest valve or valves to the existing system.

### 3.14 EXTERIOR PIPING INSTALLATION

- A. Install exterior water service piping in compliance with local governing regulations.

### 3.15 STERILIZATION AND FLUSHING OF DOMESTIC WATER PIPING

- A. After completion of water piping installation, but prior to connection to existing mains, flush system. Take sample of water from system to determine compliance with Health Department standards. Obtain necessary tests from governing Health Department. If sample is not in compliance, perform sterilization.
- B. Sterilize for eight hour contact time with 50 parts per million chlorine concentration. Open valves several times. Follow by flushing with clean water until residual chlorine is less than 0.2 parts per million. Sterilizing non-potable water piping not required.

**SECTION 22 11 20  
PLUMBING VALVES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes valves and associated appurtenances for plumbing systems. Valves specific to a single system are specified in that particular Section.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ANSI/ISEA Z358.1, American National Standard for Emergency Eyewash and Shower Equipment.
  - 2. ASME B31.1, Power Piping.
  - 3. ANSI/ISEA Z358.1, American National Standard for Emergency Eyewash and Shower Equipment.
  - 4. ASSE 1017, Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
  - 5. ASSE 1069, Performance Requirements for Automatic Temperature Control Mixing Valves.
  - 6. ASSE 1070, Performance Requirements for Water Temperature Limiting Devices.
  - 7. ASSE 1071, Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment.
  - 8. ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - 9. ASTM B 61, Standard Specification for Steam or Valve Bronze Castings.
  - 10. ASTM B 62, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - 11. ASTM B 283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot Pressed).
  - 12. MSS SP-70, Gray Iron Gate Valves, Flanged and Threaded Ends.
  - 13. MSS SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
  - 14. MSS SP-80, Bronze Gate, Globe, Angle, and Check Valves.
  - 15. MSS SP-110, Ball Valves Threaded, Socket-Welding, Socket Joint, Grooved and Flared Ends.
  - 16. MSS SP-125, Grey Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves.
  - 17. ASTM B 584, Standard Specification for Copper Alloy Sand Castings for General Applications.
  - 18. NSF 61, Drinking Water System Components – Health Effects.
  - 19. NSF 372, Drinking Water Systems Components – Lead Content.
  - 20. UL 873, Standard for Temperature-Indicating and Regulating Equipment.

- C. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI-accredited, third party certification organization to requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.

### 1.03 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Gate valves.
  - 2. Ball valves.
  - 3. Swing check valves.
  - 4. Non-slam check valves.
  - 5. Drain valves.
  - 6. Balancing valves.
  - 7. Relief valves.
  - 8. Pressure reducing valves.
  - 9. Vacuum relief valves.
  - 10. Thermostatic mixing valves.
  - 11. Valve operators.
  - 12. Blank copy of start-up test and report form.
- C. Test Reports:
  - 1. Field start-up and test reports.
  - 2. Submit completed copy of report and include copy in the Operations and Maintenance Manual.
- D. Certificates: Compliance with NSF 61 and NSF 372 for no-lead/lead-free.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Furnish factory-fabricated valves recommended by manufacturer for use in service indicated. Furnish valves of types and pressure ratings indicated but rated at not less than 125 psig WSP to comply with installation requirements. Furnish sizes as indicated with connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is the Contractor's option. Refer to other Sections for higher working steam pressures.
- B. Rubber, plastic, and silicone gaskets not acceptable for domestic water systems.
- C. Press Joint Valves: Use with press joint copper piping systems as specified in Section 221116 for sizes 1/2 inch through 2 inch.
- D. Manufacturers: Fairbanks, Hammond Valve, Red-White Valve Corp., Jenkins, Milwaukee Valve Co., NIBCO, Powell, Stockham, Walworth Valves, DFT® Inc., Metraflex Co., Jomar Group, Kitz, Apollo®/Conbraco Industries, Inc. **OR APPROVED.**

**2.02 GATE VALVES**

- A. General: Select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened. Equip with gland follower. Comply with the following standards:
  - 1. Bronze Valves: MSS SP-80.
  - 2. Cast Iron Valves: MSS SP-70.
- B. 2 inch and Smaller: Bronze, solid bronze wedge disc, nonrising stem, screwed or soldered joint ends, union bonnet, ASTM B 62.
- C. 2-1/2 inch and Larger: Cast iron body, solid wedge disc, bronze trim, flanged, OS&Y, bolted bonnet, ASTM A 126. FDA epoxy coating on internal components acceptable.

**2.03 BALL VALVES**

- A. General: Select with port area equal to or greater than connecting pipe area, include seat ring designed to hold sealing material. Comply with MSS SP-110.
- B. Bronze body, 600 pound, chrome plated ball and stainless steel stem, full port, screwed or solder joint ends, 2 piece construction, lever handle, Teflon seat and seal, memory stop, ASTM B 61, ASTM B 62, or ASTM B 584. Include extended stem, protective sleeve, and fully adjustable memory stop after insulation is applied where valves are insulated. Lead free, cast iron with epoxy coating on internal components or bronze body with Type 316 stainless steel ball and stem acceptable for sizes 2-1/2 inch and larger.

**2.04 SWING CHECK VALVES**

- A. General: Construct valves of pressure castings free of impregnation materials. Include stop plug as renewable stop for disc hanger. Construct disc and hanger as separate parts, with disc free to rotate. Support hanger pins on both ends by removable side plugs. Comply with the following standards for design, workmanship, material and testing:
  - 1. Bronze Valves: MSS SP-80.
  - 2. Cast Iron Valves: MSS SP-71.
- B. 2 inch and Smaller: Bronze, screwed cap, bronze or brass swing disc, Y-pattern, screwed or solder joint ends, ASTM B 62.
- C. 2-1/2 inch and Larger: Cast iron body, flanged, bolted cap, swing pattern, ASTM A 126, renewable cast iron disc with bronze disc face ring and seat to ASTM B 584 except valves larger than 4 inch may be furnished with cast iron disc to ASTM A 126. FDA epoxy coated internal surfaces acceptable.

**2.05 NON-SLAM CHECK VALVES**

- A. For vertical upward fluid flow. Comply with the following standards:
  - 1. Bronze Valves: MSS SP-80.
  - 2. Cast Iron Valves: MSS SP-125.

- B. 2 inch and Smaller: Brass body, screwed or solder joint ends, Type 304 stainless steel or bronze spring, brass disc holder, PTFE or Buna-N disc, ring, ASTM B 61 or ASTM B 62. Cast iron valves, ASTM A 126, acceptable.
- C. 2-1/2 inch and Larger: Cast iron body, clear or full waterway, globe style, flanged, bronze trim, stainless steel spring and screw, ASTM A 126. FDA epoxy coated internal surfaces acceptable.

**2.06 DRAIN VALVES**

- A. Bronze body, composition disc, 3/4 inch handwheel, screwed or solder joint ends hose thread outlet with cap. At the Contractor's option, full port ball valve acceptable.

**2.07 BALANCING VALVES**

- A. Description: Valves for variable orifice flow measurement and balancing. Positive shutoff with memory stop indicator.
- B. Construction: Brass alloy body ASTM B 283, Type 304 stainless steel ball, brass readout valves with EPT check valves. EPDM stem "O" ring, solder connections, 360 degree handwheel adjustment, and 1/4 inch NTP tapped and plugged drain port.
- C. Manufacturers: Bell & Gossett Circuit Setter® Plus Model RF-LF or CB-RF Series, Victaulic Co., or approved.

**2.08 RELIEF VALVES**

- A. General: CSA rated. Select for capacity to exceed rating of connected equipment. Watts Water Technologies Inc. No. 100XL for temperature and pressure applications and Watts Water Technologies Inc. No. 174A for pressure only applications, Cash Acme® or approved.

**2.09 PRESSURE REDUCING VALVES**

- A. General: Water regulators with factory or field installed strainer, screwed or flanged ends, Buna-N diaphragm, and stainless steel internal components.
- B. 3 inch and Smaller: Brass body with screwed ends. Include factory strainer, built-in bypass feature, and EDPM valve disc, 300 psig maximum working pressure, 25 to 75 adjustable reduced pressure range. Watts Water Technologies Inc. No. LFN223BS, Cash Acme®, Zurn-Wilkins, or approved.

**2.10 VACUUM RELIEF VALVES**

- A. Low lead brass body, high heat resistant disc. Valve closes quickly and tightly under pressure and opens on vacuum of not over 1/2 inch mercury. Watts Water Technologies Inc. No. N36 or approved.

**2.11 THERMOSTATIC MIXING VALVES, SINGLE LAVATORY/POINT OF USE**

- A. General: Self-contained thermostatic mixing valve, factory assembled and tested, with solid bimetal thermostat to control hot and cold water intake and to compensate for supply temperature and pressure fluctuations. Comply with ASSE 1070 for a single fixture served by valve. Thermostatic mixing valves with paraffin based temperature control acceptable.



- B. Construction: Rough bronze finish with bronze, brass, and stainless steel internal components.
- C. Components:
  - 1. Integral plastic temperature adjustment cap with vandal resistant locking screw.
  - 2. Adjustable high temperature limit stop set for 120 F.
  - 3. Union angle check valves on inlets.
- D. Manufacturers: Leonard Valve Co. Model 170-LF, Powers LFG480, Acorn Engineering Co. Model ST70, or approved.

**2.12 THERMOSTATIC MIXING VALVES, SINGLE ASSEMBLY, SIZES 3/4" - 1-1/2"**

- A. General: Self-contained thermostatic mixing valve, factory assembled and tested, with solid bimetal thermostat to control hot and cold water intake and to compensate for supply temperature and pressure fluctuations. Comply with ASSE 1070 for single fixtures and ASSE 1069 for multiple fixtures served by valve. Thermostatic mixing valves with paraffin based temperature control acceptable.
- B. Construction: Rough bronze finish with bronze, brass, and stainless steel internal components.
- C. Components:
  - 1. Integral wall support and plastic handle with locking temperature regulator.
  - 2. Adjustable high temperature limit stop set for 120 F.
  - 3. Outlet ball valve and pressure gage.
  - 4. Union angle check stops on inlets.
  - 5. Color coded dial thermometer with directional indicators.
  - 6. Cabinet: recessed
- D. Manufacturers: Leonard Valve Co. Type TM, Powers LFMM 430, Acorn Engineering Co. Model MV 17, Lawler Manufacturing Company Series 61, or approved.

**2.13 THERMOSTATIC MIXING VALVES, DIGITAL CONTROL ASSEMBLY**

- A. General: Factory assembled and tested system with digital control and monitoring system with self-contained mixing valve to control mixed water outlet to plus or minus 2 F. Comply with ASSE 1017 and UL 873.
- B. Construction: Lead free copper assembly mounted on welded strut with corrosion resistant coating meeting requirements of NSF 372.
- C. Digital Water Temperature Controller: Monitor and display the following on 3-1/2 inch color touchscreen
  - 1. Hot and cold water inlet supply pressure.
  - 2. Hot and cold water inlet supply temperature.
  - 3. Mixed outlet temperature and setpoint.
  - 4. Return water temperature and pressure.
  - 5. Mixed outlet and return flow.
  - 6. Energy units displayed in kilowatts.
  - 7. Highest mixed outlet temperature recorded since last reset.

8. Lowest mixed outlet temperature recorded since last reset.
9. Domestic hot water circulation pump run time.
10. Energy consumed since last reset.
11. Highest hot water supply temperature since last reset.
12. Lowest hot water supply temperature since last reset.
13. Highest measured load flow since last reset.
14. Control module password protected.
15. Communication: BACnet and Modbus protocols.

D. System Characteristics:

1. Maximum Operating Pressure: 125 psig.
2. Maximum Hot Water Temperature: 200 F.
3. Minimum Hot Water Supply Temperature: 2 F above setpoint.
4. Hot Water Outlet Temperature Range: 120 F to 180 F.
5. Cold Water Inlet Range: 39 F to 80 F.
6. Minimum Flow: 0.5 gpm.
7. Temperature Adjustment Range: 80 F to 180 F.
8. Pump Relay: 16 A at 250 VAC.
9. Alert Relay: 5 A at 250 VAC or 5 A at 30 VDC.

E. Manufacturers: Powers™ IntelliStation™, Armstrong International The Brain®, Acorn Controls BASyC™, or approved.

#### 2.14 THERMOSTATIC MIXING VALVES, EMERGENCY FIXTURES

A. General: Self-contained thermostatic mixing valve with solid bimetal thermostat, factory assembled and tested. Valve closes on failure of cold water. Include internal bypass to ensure cold water flow on failure of hot water. Comply with ANSI/ISEA Z-358.1 and ASSE 1071. Thermostatic mixing valves with paraffin based temperature control acceptable.

B. Construction: Rough bronze.

C. Components:

1. Locking type temperature regulator set for 85 F.
2. Union angle check stops on inlets.
3. Adjustable high temperature limit stop set for 90 F.
4. Dial thermometer.

D. Manufacturers or approved:

1. Leonard Valve Co. Model TA-300-LF for emergency eyewashes.
2. Powers™ HydroGuard Model ES-150 for emergency eyewashes.
3. Acorn Controls Model ET 71-1 for emergency eyewashes.

#### 2.15 VALVE OPERATORS

A. Valves in Mechanical and Boiler Rooms and Above Suspended Ceilings: Include valve with chain operator complete with sprocket rim and chain guide and hot dipped galvanized chain for valves 4 inch and larger in mechanical rooms and boiler rooms and for valves 2-1/2 inch and larger where installed above suspended ceilings.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 WORK PRIOR TO INSTALLATION

- A. Thermostatic mixing valve manufacturer's authorized representative shall meet with plumbing subcontractor at job site to assure that parties understand what interconnections are required.
- B. After thermostatic mixing valve installation, manufacturer's authorized representative to meet again with mechanical subcontractor to review the installation, advise as to any required changes, and make final adjustments to mixing valves and high temperature limit stops.

3.05 INSTALLATION

- A. Install valves where required for proper operation of piping and equipment, including valves in branch lines to isolate Sections of piping. Locate valves in accessible locations. Install gate valves 6 inch and larger with separate support so that valve weight is not imposed on adjacent piping.
- B. Valve Stem Position:
  - 1. Gate and Ball Valves: Install horizontal or above.
- C. Check Valves:
  - 1. Swing type check valves installed in vertical pipes not acceptable.
  - 2. Install non-slam check valves in pump discharge pipes and in vertical pipes.
- D. Install isolation valves where indicated on the Drawings and in the following locations:
  - 1. Branch lines.
  - 2. Branch mains.
  - 3. At connections to equipment.

- E. Install drain valves at low points of plumbing systems and as indicated on the Drawings.
- F. Install balancing valves with reducers upstream and downstream of valve connections. Install valves with straight pipe upstream and downstream as required by manufacturer's installation instructions.
- G. Install pressure reducing valves with either factory furnished or field furnished low pressure Y-type strainer as specified in Section 232116.
- H. Install isolation valves upstream of balancing valves.
- I. Install valve operators with chains for valves located with horizontal centerline more than 7 feet above floor and where installed with horizontal centerline more than 6 inch above suspended ceilings. Terminate chain 4 feet above floor and 6 inch above ceiling.
- J. Install 12 inch long orange colored 1/2 inch wide surveyors' tape on valves located above ceilings.
- K. Copper Press Fitting Valves: Use only for copper press fitting piping systems specified in Section 221116.

**3.06 PLUMBING SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

**3.07 COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

- C. Comply with requirements of ASHRAE Standard 188 as it relates to “Requirements for Building Water Systems” and “Requirements for Designing Building Water System” which include procedures for flushing and disinfection to meet the requirements of AWWA C651 or AWWA C652 or with requirements of applicable national, regional, and local regulations, whichever is more stringent.
- D. After flushing and sterilization are complete, conduct tests to determine compliance with Health Department standards for sterilization results. If pipe system is found to be contaminated, correct defects and perform additional flushing and sterilization until satisfactory results are obtained.
- E. Submit written certification of flushing and sterilization with approved by the AHJ.

**3.16 PLUMBING SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

**3.17 COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 22 11 23  
PLUMBING PUMPS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes plumbing pumps and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASTM A 48, Standard Specification for Gray Cast Iron Castings.
  - 2. ASTM B 61, Standard Specification for Steam or Valve Bronze Castings.
  - 3. NSF 61, Drinking Water Systems Components – Health Effects.
  - 4. NSF 372, Drinking Water Systems Components – Lead Content.
  - 5. UL 508, Standard for Industrial Control Equipment.
  - 6. UL 508A, Standard for Industrial Control Panels.
  - 7. UL 778, Motor-Operated Water Pumps.
  - 8. UL 2043, Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
- C. Domestic Water Booster Assembly: Manufacturer of assembly shall be the manufacturer of control panel and shall be listed by UL 508A as an approved manufacturer of industrial control panels.
- D. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI-accredited, third party certification organization to requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following. Include each type of piping, fittings, and associated appurtenances.
  - 1. Domestic hot water circulating pumps.
  - 2. Domestic water pressure booster assembly.
  - 3. Pump discharge flexible connectors.
  - 4. Blank copy of start-up test and report form.

- C. Shop Drawings for Domestic Water Booster Assembly:
  - 1. Template with dimensions for anchor bolts.
  - 2. Assembly dimensions and general arrangements of components and specialties.
  - 3. Control panel drawing with operator interfaces.
  - 4. Electrical power and control wiring diagram.
  
- D. Pump Curves: Submit head, efficiency, brake horsepower, and NPSH curves compared to capacity for each pump and for combined pumps operating in parallel or series. Plot curves from zero to maximum flow. Indicate pump operating point. Identify pump equipment number, fluid pumped, specific gravity, pump speed, and impeller size. Submit family of impeller curves for selected pump size. A single pump curve not acceptable.
  
- E. Test Reports:
  - 1. Start-up and field test reports.
  - 2. Factory domestic water booster assembly pressure and control system tests report.
  - 3. Site visit reports.
  - 4. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

## PART 2 - PRODUCTS

### 2.01 SELECTION

- A. Pumps are selected in mid-range of available impeller diameters for a given pump, at no less than 2/3 flow rate at maximum efficiency, and with a drive motor sized to operate non-overloading at any point on the pump curve for the impeller selected.
  
- B. Pump casing shall be sized large enough to accommodate impeller at least 1 cataloged diameter larger than size of impeller to be furnished.
  
- C. Pump shall have maximum 15 feet per second discharge velocity.

### 2.02 DOMESTIC HOT WATER CIRCULATING PUMPS

- A. Description: Centrifugal, in-line, close-coupled, single stage, electric motor-driven, suitable for domestic water. Certified and labeled to NSF 61 for potable drinking water. Integral 24 hour timer switch and thermostatic control.
  
- B. Construction: Pump volute and impeller Type 316L stainless steel construction, screwed connections or flanged ends with screwed companion flanges. Include drain and vent plug.
  
- C. Shaft Seals: Mechanical, Viton, carbon on silicon carbide.
  
- D. Motor: NEMA Standard open drip proof, permanent split-capacitor with thermal overload protection and permanently lubricated ball bearings, single speed. Shaft material Type 316 stainless steel. Comply with requirements in Section 230513.
  
- E. Manufacturers: Bell & Gossett 3530 Series Armstrong Fluid Technology, Grundfos Pumps, or approved.

2.03 DOMESTIC WATER PRESSURE BOOSTER ASSEMBLY

- A. Description: Factory assembled and tested with 2 pumps. Package shall require only pipe connections, One electrical power connection and necessary terminal contacts to various field mounted devices and Direct Digital Control (DDC) system specified in Section 230900. Package shall consist of system base, pumps, electric motors, controls, hydropneumatic tank, valves, piping, and components for complete system certified and labeled to NSF 61 for potable drinking water.
- B. Components:
1. General: Components mounted on structural steel base. Base large enough to support pumps, piping, and control panels. Steel supports welded to base to support piping and control panel.
  2. Pumps: Vertical in-line electric motor driven with TEFC motor driven by integrated variable frequency drive. Comply with requirements in Section 230513.
  3. Hydropneumatic Tank: Bladder type with orifice, capacity as indicated in equipment schedules, 125 psig ASME rated.
  4. Piping, Fittings, and Accessories: Comply with requirements in Section 221116. Include base mounted supports for suction and discharge piping. Support piping independently of pump connections. Arrange pipe supports to permit field installation of insulation, thickness as specified in Section 230700.
  5. Valves: Comply with requirements in Section 221120 for pump suction and discharge isolation valves. Include combination pilot operated pressure regulating/non-slam check valve for each pump.
  6. Gasket Material: EDPM, NBR, or SBR only. Buna (except for the bladder in the hydropneumatic tank) and PTFE not acceptable.
  7. Pressure Gages: Comply with requirements in Section 221116.
  8. Vibration Isolation and Seismic Restraints: Comply with requirements in Section 230548 and Section 230550.
  9. Pump System Controller:
    - a. The pump system controller shall be a standard product developed and supported by the pump manufacturer.
    - b. The controller shall be microprocessor based capable of having software changes and updates. via personal computer (notebook). The controller user interface shall have a color display with a via personal computer (notebook). The controller user interface shall have a color display with a minimum screen size of 3-1/2" x 4-5/8" for easy viewing of system status parameters and for field programming. The display shall have a back light with contrast adjustment.
    - c. Backup battery: The controller shall have the ability to be connected to a backup battery to supply power to the controller during periods of loss of supply power.
    - d. Home Status Screen: The controller shall display the following as status readings from a single display on the controller (this display shall be the default):
      - 1) Current value of the control parameter, (typically differential pressure).
      - 2) Most recent existing alarm (if any).
      - 3) System status with current operating mode.



- 4) Status of each pump with current operating mode and rotational speed as a percentage (%).
  - 5) Estimated flow-rate, (or actual flow if flow sensor is used).
  - 6) One user defined measured parameter (i.e. power consumption).
- e. Inputs/Outputs: The controller shall have as a minimum the following hardware inputs and outputs:
- 1) Three analog inputs (4-20mA or 0-10VDC).
  - 2) Three digital inputs.
  - 3) Two digital outputs.
  - 4) Ethernet connection (built-in web server).
  - 5) Field service connection to PC for advanced programming, software and/or firmware upgrades and data logging.
- f. Pump system programming: As a minimum, the following parameters shall be available and/or field adjustable:
- 1) Sensor Settings: suction, discharge, differential pressure.
  - 2) PI Controller: proportional gain (Kp) and integral time (Ti).
  - 3) Low suction: pressure/level shutdown via digital contact.
  - 4) Limit Exceeding function: For low system, low suction warnings and shut down.
- g. Pump Curve Data: The actual pump performance curves (5th order polynomial) shall be loaded (software) into the pump system controller. Pump curve data shall be used for the following:
- 1) Display and data logging of calculated flow rate.
  - 2) Variable pressure control (quadratic or proportional).
  - 3) Pump outside of duty range protection.
  - 4) Sequence pumps based on efficiency.
- h. Variable Pressure Control: The controller shall have variable pressure control to compensate for pipe friction loss by decreasing the pressure set-point at lower flow-rates and increasing the pressure set-point at higher flow-rates by using the actual flow rate or calculated flow rate. Variable pressure control that uses power consumption and speed only shall not be considered equal to variable pressure control that uses actual differential pressure measurement along with pump power and speed.
- i. Check Valve Failure Detection (Systems with integrated VFD motors): The system controller shall be able to detect motors turning in the opposite direction and give check valve failure notification.
- 1) For minor leaks the pump shall start with a warning indicated.
  - 2) For major leaks the pump shall remain off to prevent damage with an alarm indication.
- j. Remote Control: The controller shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.

- k. Setpoint Ramp: The controller shall be able to adjust the ramp time of a change in set point (increase and decrease).
  - l. Warnings and Alarms: The pump system controller shall store up to 24 warnings and alarms in memory. The time, date and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. The controller shall display the following alarm conditions:
    - 1) Individual pump failure.
    - 2) Check valve failure.
    - 3) VFD trip/failure.
    - 4) Loss of sensor signal (4-20 mA).
    - 5) Loss of remote set-point signal (4-20mA).
    - 6) External fault.
    - 7) Pump outside of duty range.
  - m. Built-in data log: The controller shall have built-in data logging capability.
  - n. Power and Energy Consumption: The controller shall be capable of displaying instantaneous power consumption (Watts or kilowatts) and cumulative energy consumption (kilowatt-hours).
10. Control Panel: The pump system controller shall be mounted in a UL Type 3R rated enclosure. The entire UL Type 3R control panel shall be UL 508 listed as an assembly. The control panel shall include a main disconnect, circuit breakers for each pump and the control circuit and control relays for alarm functions.
- a. The control panel shall include the following:
    - 1) 80 dB system fault audible alarm with push button to silence.
    - 2) Emergency/normal operation switches (control bypass).
    - 3) Individual service disconnect switches (accessible outside of panel).
    - 4) Pump run lights.
    - 5) System fault light.
    - 6) Surge arrestor.
  - b. DDC Integration: BACnet IP.
11. Electrical Wiring: Comply with requirements in Division 26.
- C. Source Quality Control:
- 1. After factory assembly, hydrostatically test assembly to 150 psig for 30 minutes minimum. Test control system and simulate sequences and alarms.
  - 2. Include test reports in the Operations and Maintenance Manual.
- D. Manufacturers: Grundfos Pumps, Bell & Gossett, TIGERFLOW Systems, LLC or approved.

#### 2.04 PUMP DISCHARGE FLEXIBLE CONNECTORS

- A. Description: Factory assembly with carbon steel vane within corrugated hose with stainless steel woven wire braid between 150 psig carbon steel flanges. Include carbon steel reducing elbow for horizontal discharge pump.

- B. Manufacturer: Metraflex VaneFlex™ or approved.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

#### 3.04 INSTALLATION OF PUMPS

- A. General: Support pumps and piping separately so piping is not supported by pumps.
- B. In-Line Pumps: Provide rod hangers to support independently from piping system with access to oil cups, service, and maintenance. Mount maximum of 5'-0" above floor. Comply with requirements in Section 230510 for rod hangers, Section 230548 for vibration isolators, and Section 230550 for seismic restraints.

#### 3.05 DOMESTIC WATER BOOSTER ASSEMBLY START-UP SERVICES

- A. Assembly manufacturer's authorized representative shall perform start-up services. Services shall include check of installation, system check-out, adjustment, and start-up. Include 2 on-site job visits. The first visit shall be a preliminary check of installation by the installing contractor. This first visit shall occur only when all hookups, tie-ins and terminations have been completed. Subsequent visit shall occur for final checkout, adjustment, and start-up purposes. Submit completed checklists or reports detailing activities for both visits to the A/E. Start-up by the Contractor not acceptable.
- B. System manufacturer shall have factory trained authorized service agency with a minimum of 2 service technicians available 24 hours a day, 7 days a week, and located within 50 miles of project site.

#### 3.06 PLUMBING SYSTEMS TRAINING

- A. Comply with requirements in Section 230810.

3.07 **COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 22 13 00**  
**SOIL, WASTE, VENT, AND STORM DRAIN PIPING SYSTEMS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes building drainage piping and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Applicable plumbing code pertaining to materials, products, and installation of soil, waste, vent, and storm drain piping.
  - 2. ASME A112.1.2, Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors).
  - 3. ASME A112.6.3, Floor and Trench Drains.
  - 4. ASME A112.36.2, Cleanouts.
  - 5. ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.
  - 6. ASME B16.12, Cast Iron Threaded Drainage Fittings.
  - 7. ASME B16.23, Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
  - 8. ASME B16.29, Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings (DWV).
  - 9. ASSE 1021, Drain Air Gaps for Residential Dishwasher Applications.
  - 10. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 11. ASTM A 74, Standard Specification for Cast Iron Soil Pipe and Fittings.
  - 12. ASTM A 106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
  - 13. ASTM A 888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
  - 14. ASTM B 306, Standard Specification for Copper Drainage Tube (DWV).
  - 15. ASTM C 564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
  - 16. ASTM C 1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
  - 17. ASTM C 1540, Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Sewer Pipe and Fittings.
  - 18. AWWA C 110/A 21.10, Standard for Ductile-Iron and Gray - Iron Fittings.
  - 19. AWWA C 111/A 21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - 20. AWWA C 151/A 21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
  - 21. AWWA C 153/A21.53, Standard for Ductile-Iron Pipe Compact Fittings for Water Service.

22. CISPI 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
23. CISPI 310, Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
24. FM 1680, Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/Commercial and Residential.
25. IGC 237, IAPMO Guide Criteria for High Pressure Stainless Steel Shielded Couplings for Use with Hubless Cast Iron Soil Pipe and Fittings.

### 1.03 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following.
  1. Piping, tubing, and fittings.
  2. Cleanouts.
  3. Vents through roof.
  4. Floor drains.
  5. Floor sinks.
  6. Interceptors and separators.
  7. Piping specialties.
  8. Blank copy of start-up and test report form.
- C. Shop Drawings: Comply with requirements in Section 230500.
- D. Test Reports:
  1. Field start-up and test reports.
  2. Submit completed copy of report and include copy in the Operations and Maintenance Manual.

### 1.04 DEFINITIONS

- A. The term "floor receptor" may be used on the Drawings. This term means "floor drain", "funnel floor drain", "floor sink", or similar device as applicable.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Furnish products of sizes, ratings, and characteristics indicated which comply with manufacturer's standard materials, design, and construction in accordance with published product information. Furnish quantity of piping and appurtenances required for complete installation.
- B. Piping specified in this Section apply to the following systems:
  1. Waste and vent.

2. Indirect drain for equipment, air vent, cooling coil condensate drains and similar applications.

2.02 **MANUFACTURERS**

- A. Drains, Cleanouts, and Miscellaneous: Jay R. Smith Mfg. Co., Josam Co., Wade Mfg. Co., Zurn Wilkins, Watts Water Technologies, Highland Tank, Eric'sons, or approved. Jay R. Smith model numbers are listed.

2.03 **PIPING, TUBING, AND FITTINGS**

- A. Piping Materials:
  1. Cast Iron:
    - a. Pipe and Fittings: Service weight cast iron soil pipe marked with collective trademark of Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International. ASTM A 888 or CISPI No. 301. AB&I Foundry, Charlotte Pipe and Foundry Co., or Tyler Pipe. No substitutions.
    - b. Hubless Joints: ASTM A 888 or CISPI No. 310 for heavy duty and standard duty couplings. Tested to ASTM D 3677.
      - 1) Heavy Duty Couplings for Underground Pipe and Fittings: Comply with ASTM C 1540, Type 304 stainless steel housing or shield and stainless steel clamps, neoprene gasket with sealing rings to ASTM C 564 or ASTM C 1277. Clamp-All HI TORQ 125, Anaco-Husky SD 4000 or Thermafit Industries POC. NewAge Casting acceptable.MG Couplings cast iron split clamps with stainless steel nuts and bolts and neoprene gasket acceptable
      - 2) Standard Duty Couplings for Above Ground Pipe and Fittings: Comply with ASTM C 1540, Type 304 stainless steel housing or shield and stainless steel clamps, neoprene gasket with sealing rings to ASTM C 564 or ASTM C 1277. Clamp-All HI TORQ 80, or Anaco-Husky HD 2000, Mission Rubber Company LLC HeavyWeight, Ideal Tridon Couplings Heavy Duty, or Tyler Pipe. Thermafit Industries POC and NewAge Casting acceptable.
    - c. Fittings: ASTM A 74 for hub and spigot piping and ASTM A 888 or CISPI 301, and CISPI 310 for hubless piping.
    - d. Hubless Joint Restraints: Galvanized steel straps and band clamps. HOLDRITE<sup>®</sup> 117 Series, or approved.
  2. Galvanized Steel:
    - a. Pipe: Standard weight or Schedule 40, ASTM A 53 or ASTM A 106.
    - b. Fittings:
      - 1) Drainage Fittings: Galvanized cast iron drainage pattern, screwed, ASME B16.12.
      - 2) Vent Fittings: 150 pound galvanized malleable iron, screwed, ASME B16.3.

3. Copper:
    - a. Pipe: Type DWV, hard drawn drainage tubing, ASTM B 306.
    - b. Fittings: Cast copper, ASME B16.23 or wrought copper, ASME B16.29, solder joint.
  4. Ductile Iron:
    - a. Pipe: Mechanical joint, AWWA C151, with bell and spigot end.
    - b. Fittings: Ductile or gray iron standard pattern, AWWA C110, or ductile iron compact pattern, AWWA C153.
    - c. Glands, Gaskets, Tie Rods, and Bolts: Ductile or gray iron glands, rubber gaskets and steel tie rods and bolts, AWWA C111.
- B. Above Ground Drain, Waste, and Vent Piping:
1. 1-1/2 Inch and Smaller: Galvanized steel, cast iron, or copper.
  2. 2 Inch and Larger: Cast iron.
- C. Underground Drain, Waste, and Vent Piping: Cast iron.
- D. Indirect Drain (Condensate) Piping: Copper.

#### 2.04 CLEANOUTS

- A. Standard: Fabricate in accordance with ASME A 112.36.2M.
- B. Floor Cleanouts (FCO) in Finished Spaces: Coated cast iron body and frame, round adjustable secured nickel-bronze top, taper thread, bronze plug. Include carpet clamping frame where installed in floors with carpet. Verify floor finish with room finish schedule on architectural drawings. Jay R. Smith Figure 4023S.
- C. Floor Cleanouts (FCO) in Finished Spaces: Coated cast iron body and frame, square adjustable secured nickel bronze top, with 1/8 inch tile recess, taper thread bronze plug. Verify floor finish with room finish schedule indicated on architectural drawings. Jay R. Smith Figure 4163S4203S.
- D. Floor Cleanouts (FCO) in Unfinished Spaces: Coated cast iron body and frame, round adjustable scoriated cast iron top with non-tilt heavy duty top, taper thread, bronze plug. Jay R. Smith Figures 4243S or 4253S.
- E. Wall Cleanouts (WCO): Cast bronze plug with taper thread, round stainless steel cover and vandal proof screw. Length of screw to suit installation requirements. Jay R. Smith Figure 4472T.
- F. Exterior Cleanout (ECO): Coated cast iron body and frame with extra heavy duty, round adjustable scoriated secured cast iron top, taper thread, bronze plug. Jay R. Smith Figure 4223S.



2.05 **VENTS THROUGH ROOF**

- A. Vent Flashings:
  - 1. Dektite flashings (flexible rubber boot flashing) at pipe penetrations through steel or composition roofs.
  - 2. Use 4 pound per square foot seamless lead flashing skirt, minimum of 8 inch extending from pipe, with conical galvanized steel reinforcing boot and counterflashing fitting on built-up roofing.
- B. Vandal Proof Vent Caps: Coated cast iron, full size of vent pipe, caulked base connection for cast iron pipes, threaded base for steel pipes with recessed set screw. Jay R. Smith Figure 1748.

2.06 **FLOOR DRAINS**

- A. Standard: Fabricate in accordance with ASME A 112.6.3.
- B. FD-1, Floor Drain, Finished Areas: Two-piece coated cast iron body, double drainage flange, reversible flashing collar, weepholes, bottom outlet, 5 inch adjustable roundsquare nickel bronze strainer, and vandal proof screws. Jay R. Smith Figure 2005.
- C. FD-1, Floor Drain, Unfinished Areas: Two-piece coated cast iron body, double drainage flange, reversible flashing collar, weepholes, bottom outlet, 7 inch adjustable square nickel bronze strainer, sediment bucket, and vandal proof screws. Jay R. Smith Figure 2005.
- D. FFD-1, Funnel Floor Drain: Two-piece coated cast iron body, double drainage flange, reversible flashing collar, weepholes, bottom outlet, adjustable square polished bronze strainer, and 6 inch diameter polished bronze funnel assembly. Jay R. Smith Figure 3510 modified with Figure 3581 funnel.
- E. Trap Primer Fittings: Coated cast iron with 1/2 inch threaded inlet tapping. Jay R. Smith Figure 2695.

2.07 **FLOOR SINKS**

- A. Standard: Fabricate in accordance with ASME A 112.6.3.
- B. FS-1, Floor Sink without Grate: 12 inch square top, less rim and grate, 8 inch deep minimum 16 gage Type 304 stainless steel receptor, no hub, dome bottom strainer, flange and flashing clamp for above grade installations, Jay R. Smith Figure 3003.
- C. Trap Primer Fittings: Coated cast iron with 1/2 inch threaded inlet tapping. Jay R. Smith Figure 2695.

## 2.08 INTERCEPTORS AND SEPARATORS

- A. Air Gap, Fixed: Cast iron, set screw inlet connection, threaded, no-hub, or spigot outlet, maximum 20 inch long, located between drain outlet and plumbing drainage system to prevent cross-connection. Fabricate in accordance with ASME A112.1.2. Jay R. Smith Figures 3950, 3951, or 3955.
  - 1. Dishwasher Air Gap Fittings:
    - a. Fitting: ASSE 1021, fitting suitable for deck mounting for use with domestic dishwashers. Plastic body, chrome-plated brass cover and capacity of 5 gpm minimum. Inlet pressure of 5 psig minimum at temperature of 140 F minimum. Include 5/8 inch ID inlet and 7/8 inch ID outlet hose connections.
  - 2. Hoses: Rubber suitable for temperature of 140 F minimum.
    - a. Inlet Hose: 5/8 inch ID, 48 inch long.
    - b. Outlet Hose: 7/8 inch ID, 48 inch long.

## 2.09 PIPING SPECIALTIES

- A. Pipe Sleeves: Comply with requirements in Section 230510. Use black steel or cast iron pipe for pipe sizes 6 inch diameter and larger.
- B. Pipe Hangers and Supports: Comply with requirements in Section 232116.
- C. Pipe Escutcheons: Comply with requirements in Section 232116.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

### 3.04 PIPING INSTALLATION

#### A. General:

1. Install with uniform pitch of at least 1/4 inch per foot for horizontal waste piping, unless otherwise indicated on the Drawings or allowed by the AHJ.
2. Install cast iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook".
3. Pitch vents for proper drainage. Vent piping may be installed horizontal if required to avoid conflict with building elements.
4. Joints and Connections:
  - a. Hubless: Alternately and incrementally tighten clamp bolts to manufacturer's recommended torque value, using single setpoint torque wrench specifically manufactured for this purpose. Do not use screwdrivers or other types of wrenches. Retorque after 24 hours if required by manufacturer's installation instructions. Install with hubless fitting restraints at branch openings and changes in direction per CISPI No. 310 for pipe sizes 5 inch and larger.
5. Copper waste piping for urinals not acceptable.
6. Clean interior of piping. Remove dirt and other superfluous material as work progresses.
7. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

#### B. Above Ground Piping:

1. Support horizontal piping to maintain alignment, prevent grade reversals, and prevent sagging.
2. Support vertical stacks at each floor with riser clamps.
3. No-Hub Piping: Provide hangers and supports per applicable plumbing code.

#### C. Underground Piping:

1. Perform trenching and backfilling associated with plumbing installation per requirements in Section 230510.
2. Laying of No-Hub Piping: Install in bedding of trench, graded to provide uniform support for pipe, and to permit joining. Install hubs at upgrade end.
3. Install piping in trenches and not supported on foundation footings or concrete walls.
4. At time of Substantial Completion, video record main waste lines. Include copy of video recording (labeled) in the Operations and Maintenance Manual.

### 3.05 CLEANOUTS

- A. Install in accordance with requirements in the applicable plumbing code. Full pipe size, 4 inch maximum. Maximum distance between cleanouts shall be 50 foot interval for piping 4 inch and smaller and 100 foot for piping 6 inch and larger.
- B. Install floor cleanouts with top cover flush with finished floor surface.
- C. Install wall cleanouts in restrooms with greater than 2 water closets and urinals.
- D. Install wall cleanout at sinks below trap arm connection.

- E. Demonstrate removal of cleanout covers.

### 3.06 VENTS THROUGH ROOF

- A. Locations shown on the Drawings are preliminary. Coordinate final locations with other trades, minimum 10'-0" from outside air intakes.
- B. Install flashings and flashing sleeves to be weatherproof. Install flanges in roofing materials to form watertight connection.
- C. Install vandal proof vent caps on each vent pipe passing through roof. Locate base of cap 6 inch above roof surface or higher where required by the applicable plumbing code. Secure set screw.

### 3.07 EQUIPMENT CONNECTIONS

- A. Install soil and waste piping runouts to plumbing fixtures and drains with approved trap and sizes indicated on the Drawings, but in no case smaller than that required by the applicable plumbing code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures and drains.
- C. Make gas- and watertight. Use 1 piece special molded gaskets for connections between outlet of fixtures and soil pipe flanges.
- D. Install trap where manufacturer does not include trap built into fixture. Install to be removable for servicing and replacement.
- E. Coordinate soil, waste, and rainleader piping as necessary to interface with floor drains, floor sinks, and roof drains.
- F. Install floor drains and floor sinks in accordance with written manufacturer's instructions at low points of surface areas to be drained or as indicated on the Drawings. Set tops of drains flush with finished floor. Coordinate with architectural drawings. Install trap primer fittings below floor drains and floor sinks so that trap primer line is not installed in concrete floor slab.
- G. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes.
- H. Install condensate drains from cooling coil condensate drains with trap. Terminate with 1 inch air gap over floor drain, floor sink, service sink, outdoors, or as indicated on the Drawings.

### 3.08 PRESSURE TESTING

- A. Test drainage piping in accordance with applicable plumbing code. Comply with requirements in Section 221116. Test by air or water for metal piping and by air for ABS piping. For installation where pressure testing was performed on multiple Sections of pipes, retest once all waste and vent piping has been installed.

3.09 **PLUMBING SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

3.10 **COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 22 15 00  
COMPRESSED AIR PIPING SYSTEMS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes compressed air piping systems and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.
  - 2. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - 3. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - 4. ASME B16.39, Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300.
  - 5. ASME B31.1, Power Piping, for compressed air piping operating at more than 150 psig.
  - 6. ASME B31.9, Building Services Piping, for compressed air piping operating at 150 psig or less.
  - 7. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 8. ASTM A 106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
  - 9. ASTM A 197, Standard Specification for Cupola Malleable Iron.
  - 10. ASTM B 32, Standard Specification for Solder Material.
  - 11. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
  - 12. ASTM B 813, Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
- C. Welding: Qualify processes and operators according to ASME BPVC.
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping".
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.

- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Indoor and outdoor compressed air piping.
  - 2. Air compressor.
  - 3. Refrigerated air dryer.
  - 4. Combination filter/regulator/lubricator.
  - 5. Automatic electronic drain.
  - 6. Quick disconnect couplings.
  - 7. Compressed air hose.
  - 8. Blank copy of start-up and test report form.
- C. Shop Drawings: Comply with requirements in Section 230500.
- D. Welding Certificates.
- E. Test Reports:
  - 1. Field start-up and test reports.
  - 2. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Furnish products of sizes, ratings, and characteristics indicated which comply with manufacturer's standard materials, design, and construction in accordance with published product information. Furnish quantity of piping and appurtenances required for complete installation.
- B. Pressure Ratings: Provide components with minimum pressure rating of 150 psig working pressure.

### 2.02 MANUFACTURERS

- A. Steel Pipe: U. S. Steel, Sharon Tube, Vision Metals LLC, California Steel Industries, Maruichi American Corporation, National Pipe & Plastics Inc., TMK IPSCO, Wheatland Tube.
- B. Copper Tubing: Cerroflow, Mueller Industries, Wolverine Tube, Inc.
- C. Steel Pipe Fittings: Anvil International, Mill Iron Works, Inc., Hackney Ladish, Inc., Ward Manufacturing LLC, Phoenix Forging Company, Allied Tube & Conduit, Tube Forgings of America Inc, Vogt Forged Steel Pipe Fittings, Bonney Forge®, Stockham Valves and Fittings.
- D. Viega, MegaPress Fittings: Fittings with zinc/nickel coating for use with IPS schedule 5 thru schedule 40 carbon steel pipe.
- E. Copper Tubing Fittings: NIBCO®, Mueller Industries, Elkhart Brass Mfg.
- F. Copper Press Fitting Couplings and Fittings:
  - 1. NIBCO® Press System™, Viega ProPress System, or Elkhart XPress. No substitutions.

- G. Gaskets: John Crane, Garlock, United Seal & Rubber Co., Anchor Seals inc, Flexitallic.
- H. Shaped Nipples: Allied Tube & Conduit, Bonney Forge®.

**2.03 INDOOR AND OUTDOOR COMPRESSED AIR PIPING**

- A. Pipe and Fittings for 2-1/2 Inch and Smaller:
  - 1. Black steel, Schedule 40, Standard weight, ASTM A 53, Grade A or B, or ASTM A 106, Grade A, B, or C.
  - 2. Fittings: 150 pound WSP, black malleable iron, screwed, ASME B16.3 and ASTM A 197.
- B. Viega, MegaPress Fittings: 2-1/2-inch and Smaller:
  - 1. Shall conform to IAPMO PS117 or ICC LC1002, FM, and UL.
  - 2. MegaPress fittings with zinc/nickel coating for use with IPS schedule 5 thru schedule 40 carbon steel pipe conforming to ASTM A53, ASTM A106, ASTM A135, or ASTM A795.
  - 3. MegaPress fittings shall have an EPDM sealing element, 420 stainless steel grip ring, 304 stainless steel separator ring, and Smart Connect (SC) feature.
- C. Copper Tubing for 2-1/2 Inch and Smaller:
  - 1. Tubing, Above Ground: Type L copper water tube, hard-drawn, ASTM B 88.
  - 2. Tubing, Underground: Type K copper water tube, soft-drawn, ASTM B 88.
  - 3. Fittings: Wrought copper fittings and screwed adapters for soldered joints, ASME B16.22.
  - 4. Unions: Wrought copper solder joint unions, ASME B16.22; cast bronze solder joint fittings, ASME B16.18.
  - 5. Solder Material: 95 percent tin, 5 percent antimony solder or 96 percent tin 4 percent silver conforming to ASTM B 32. Lead free (not more than 0.2 percent lead). Flux water soluble conforming to ASTM B 813. J.W. Harris "Bridgit", RectorSeal, Oatey SCS, Superior Flux & Mfg. Co., Worthington Industries, BerzOmatic, or approved.
- D. Copper Press Fitting Couplings and Fittings:
  - 1. Suitable for Types K and L hard drawn copper tubing for sizes 1/2 through 2-1/2 inch and soft drawn copper tubing for sizes 1/2 through 1-1/4 inch. Press-to-connect joint made with pressing tool and jaw sets recommended by fitting manufacturer. NIBCO® Press System™, Viega ProPress System, or Elkhart Xpress.
  - 2. Wrought copper fittings per ASTM B 75 conforming to ASME B16.18 or ASME B16.22. Rated to maximum 200 psig non-shock working pressure for temperature range between minus 20 F to 250 F.

**2.04 AIR COMPRESSOR**

- A. Description: Factory assembled package with compressor mounted on a horizontal receiver.



- B. Air Compressor: Splash lubricated, single acting, one or two stage as indicated in equipment schedules, air cooled, belt driven motor supported on a steel base. Compression main bearings either roller or ball type. Include continuous duty, open drip proof motor, pressure gage, gage cock, 10 micron intake air filter, discharge aftercooler, intercooler with ASME safety valve, and enclosed belt guard.
- C. Start-up Kits: Include for each compressor.
- D. Receiver: Integral, designed for 200 psig and constructed to ASME. Factory air test to 1-1/2 times working pressure. Include safety valve, pressure gage, and automatic electronic drain.
- E. Electrical and Controls: Include magnetic motor starter and high and low pressure switches for single point electrical connection.
- F. Manufacturers: Quincy, Ingersoll Rand, Quincy, Atlas Copco, or approved.

**2.05 REFRIGERATED AIR DRYER**

- A. Description: Non-cycling, refrigerated with hermetic reciprocating compressor. Capacity not less than that for the air compressor.
- B. Refrigerant: R-513a.
- C. Instrumentation: On/off switch, power on light, and refrigerant suction pressure gage.
- D. Manufacturers: Quincy, Ingersoll Rand, ZEKS, Hankison International, Pneumatech Inc., or approved.

**2.06 COMBINATION FILTER/REGULATOR/LUBRICATOR**

- A. Description: Filter element sintered polypropylene for filtration to 5 microns. Filter and lubricator with zinc metal bowls. Nitrite seals. Maximum operating condition 200 psig and 150 F. Include gage on regulator for range from 0 to 160 psig. Adjustable pressure setpoint over entire gage range. Wilkerson Corporation Combination Unit C Series or approved.

**2.07 FILTERS**

- A. Intake Air Filter: Combination intake air filter and silencer within housing for dry type filter element and silencer tubes with minimum 99 percent efficiency of particulates 10 micrometer and larger.
- B. Prefilter: Particulate type with minimum 98 percent retention efficiency of particulates 1 micrometer and larger.
- C. Final Filter: Coalescing type with minimum 99.9 percent retention efficiency of particulates 0.3 micrometer and smaller.

**2.08 AUTOMATIC ELECTRONIC DRAIN**

- A. Description: Automatic electronic drain, floating seal solenoid, adjustable drain cycle time, adjustable valve open period, 200 psig rated valve, wall mount tabs, 110 V. Quincy Northwest Posi-Drain, Ingersoll Rand or approved.

**2.09 QUICK DISCONNECT COUPLINGS**

- A. Description: Brass, 125 psig working pressure. Female side of coupling (fixed end) with male thread connection and automatic shutoff. Male side with hose stem and ball check.

**2.10 COMPRESSED AIR HOSE**

- A. Description: Multipurpose compressed air hose for use with pneumatic hand tools, 1/2 inch nominal diameter, 50 foot length. Include end fittings for connecting to quick disconnect couplings and to hand tools. Furnish 2 rolls of hose for Owner's use.

**2.11 PIPING SPECIALTIES**

- A. Pipe Sleeves: Comply with requirements in Section 230510.
- B. Flexible Connectors: Comply with requirements in Section 230548.
- C. Pipe Hangers and Supports: Comply with requirements in Section 232116.
- D. Pressure Gages: Comply with requirements in Section 232116.
- E. Pipe Escutcheons: Comply with requirements in Section 232116.
- F. Valves: Comply with requirements in Section 221120.

**PART 3 - EXECUTION**

**3.01 INSPECTION**

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to Owner.

**3.04 INDOOR AND OUTDOOR PIPING INSTALLATION**

- A. Install with minimum uniform pitch of 1/8 inch per foot towards drain.

- B. Install 6 inch long capped and valved drip leg at bottom of each air drop and at end of each main and branch main.
- C. Install piping adjacent to equipment and specialties to allow service and maintenance.
- D. Install branch connections to compressed air mains from top of main.
- E. Install pressure gage on discharge piping from each air compressor and on each receiver.
- F. Install piping free of sags and bends.
- G. Connect compressed air piping to air compressors and to compressed air outlets and equipment requiring compressed air service.
- H. Install unions adjacent to each valve and at final connection to each piece of equipment, machine and specialty.

**3.05 INSTALLATION OF COMPRESSED AIR EQUIPMENT AND COMPONENTS**

- A. Install equipment with clearances for service and maintenance.
- B. Floor Mounted Equipment:
  - 1. Install on level surface.
  - 2. Anchor bolt to housekeeping pads.
- C. Comply with requirements in Section 230548 for vibration isolators and Section 230550 for seismic restraints.

**3.06 EQUIPMENT CONNECTIONS**

- A. Connect compressed air piping to mechanical equipment as indicated on the Drawings. Comply with equipment manufacturer's installation instructions. Install shutoff valve and union for each connection and drain valve on drain connection. Locate unions to allow removal of equipment without piping disassembly beyond union. Provide 6" capped dirt leg at all equipment connections.

**3.07 FLUSHING OF COMPRESSED AIR PIPING**

- A. After completion of compressed air piping installation and prior to pressure testing, flush interior surfaces by injecting dry nitrogen into open ends of piping just prior to making final connections to equipment.

**3.08 PRESSURE TESTING**

- A. Comply with requirements in Section 230510.

**3.09 PLUMBING SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

3.10 **COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 22 30 00  
PLUMBING EQUIPMENT**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes water heaters and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Condition and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Applicable energy code.
  - 2. Applicable plumbing code pertaining to materials, products, and installation of plumbing equipment.
  - 3. ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - 4. ASME BPVC, Boiler Pressure and Vessel Code, Section VIII, Division 01, Rules for Construction of Pressure Vessels.
  - 5. ANSI Z21.10.3, Gas Water Heaters, Volume III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous.
  - 6. NSF 61, Drinking Water System Components - Health Effects.
  - 7. NSF 372, Drinking Water Systems Components - Lead Content.
- C. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI-accredited, third party certification organization to requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following. Indicate accessories where required for complete system and installation instructions.
  - 1. Water heaters, electric.
  - 2. Water heaters, tankless, electric.
  - 3. Expansion tanks.
  - 4. Drain pans.
  - 5. Blank copy of start-up test and report form.

- C. Test Reports:
  - 1. Field start-up and test reports.
  - 2. Submit completed copy of report and include copy in the Operations and Maintenance Manual.

#### 1.04 WARRANTY

- A. Water Heaters Components: Non-prorated warranty against failure due to defect in material or workmanship for number of years after Substantial Completion acceptance date specified for specific water heaters in this Section. Warranty shall cover material, labor, and travel time. Make available replacement within 48 hours of initial notification.

### PART 2 - PRODUCTS

#### 2.01 WATER HEATERS, ELECTRIC

- A. Description: Vertical tank type, commercial-grade, electric water heater.
- B. Ratings: UL listed and labeled, certification of compliance with ASHRAE 90.1, ASME labeled, 150 psig working pressure.
- C. Construction: Glass lined tank, screw-in or bolt-on immersion elements with incoloy sheathing, replaceable magnesium anode rod, cold water dip tube, round steel enclosure with label, enamel finish, insulation to meet requirements of energy code as adopted by the AHJ.
- D. Controls: Hinged control compartment with 120 V control transformer and fusing, magnetic contactors, element fusing per NEC, adjustable immersion style operating thermostats, manual reset high limit switch.
- E. Components:
  - 1. CSA rated temperature and pressure safety relief valve selected to exceed rating of water heater.
  - 2. Drain valve.
  - 3. Support legs.
- F. Manufacturers: Bradford White Corporation, A.O. Smith, Rheem Mfg. Corp., State Water Heaters, PVI Industries, Inc., Lochinvar LLC, or approved.

#### 2.02 WATER HEATERS, TANKLESS, ELECTRIC

- A. Description: Instantaneous tankless type with flow control capability for undercounter installation.
- B. Rating: UL listed and labeled, 150 psig working pressure.
- C. Construction: Plastic cover and base.
- D. Components:
  - 1. Internal components with heating system, electronic control unit, flow sensor, temperature sensor, high temperature limit cutoff device or system, and wiring block.

2. Components on cover include temperature adjustment rotary switch, power light, and LED temperature display.
3. Brackets for wall mounting.

E. Manufacturers: Hubbell, Stiebel Eltron, Eemax, Chronomite Laboratories™, or approved.

### 2.03 EXPANSION TANKS

- A. Description: Pre-charged tank. Suitable for use in potable and non-potable water systems.
- B. Ratings: ASME labeled for sizes 1-1/2 cubic feet and larger, 150 psig working pressure.
- C. Construction: Steel outer shell with butyl diaphragm and polypropylene liner with a silver-ion based antimicrobial compound.
- D. Manufacturer: Grundfos, AMTROL Therm-X-Trol, Bell & Gossett, Armstrong Fluid Technology, or approved.

### 2.04 DRAIN PANS

- A. Description: Type 304 stainless steel with raised edge, 16 gage, minimum 4 inch high with all welded joints. Size to accommodate base of water heater. Include 3/4 inch drain outlet connection.

### 2.05 EXPANSION TANK WALL SUPPORTS

- A. Description: Galvanized steel sheet metal with fasteners and stainless steel bands for vertical tanks. HOLDRITE® Thermal Expansion Tank Mounting Bracket or approved.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Coordinate required electrical and control installation work with Division 26 and Section 230900.

**SECTION 22 40 00  
PLUMBING FIXTURES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes plumbing fixtures and fittings, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 Sections apply to the Work in this Section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer. If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- C. Codes and Standards:
  - 1. Applicable plumbing code pertaining to materials, products, and installation of plumbing fixtures.
  - 2. ANSI/SEA Z385.1, American National Standard for Emergency Eyewash and Shower Equipment.
  - 3. ASSE 1011, Performance Requirements for Hose Connection Vacuum Breakers.
  - 4. ASSE 1016, Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations.
  - 5. ASSE 1019, Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance.
  - 6. ASSE 1052, Performance Requirements for Hose Connection Backflow Preventers.
  - 7. ASTM C 1822, Standard Specifications for Insulating Conversion Accessible Lavatory Piping.
  - 8. ICC A117.1, Accessible and Usable Buildings and Facilities.
  - 9. NSF 61, Drinking Water System Components – Health Effects.
  - 10. NSF 372, Drinking Water Systems Components – Lead Content.
  - 11. Public Law 102-486, Energy Policy Act.
- D. Domestic Water Systems: Products carrying and dispensing water for consumption through drinking and cooking shall be certified by an independent, ANSI-accredited, third party certification organization to the requirements of NSF 61 and NSF 372 for 0.25 percent maximum lead content for wetted component base material.
- E. Combinations of fixtures and trim, faucets, fittings, and other components that are compatible.



**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following. Indicate accessories where required for complete system. Verify as to the locations of plumbing fixture accessories such as sink bubbler, glass fillers, ADA compliant shower seats, and similar items with architectural drawings before submittals are prepared.
  - 1. Plumbing fixtures and trim.
  - 2. Fixture supports.
  - 3. Wall and floor sealant.
  - 4. Blank copy of start-up test and report form.
- C. Test Reports:
  - 1. Field start-up and test reports.
  - 2. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

**1.04 DEFINITIONS**

- A. Accessible Fixture (ADA compliant): Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fittings and Trim: Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.

**1.05 COORDINATION**

- A. Coordinate rough-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Water Closets and Urinals: Kohler Co., American Standard, Crane Plumbing, Zurn Wilkins, Sloan Valve Company, Mansfield Plumbing Products (Commercial line only), Acorn Engineering Company® or approved.
- B. Lavatories: Kohler Co., American Standard, Crane Plumbing, Acorn Engineering Company®, Bradley Corp, Mansfield Plumbing Products (Commercial line only), Zurn, Sloan Valve Company, or approved.
- C. Stainless Steel Sinks: Just Manufacturing, Elkay Mfg. Co., Kindred, or approved.
- D. Service (Mop) Sink: Fiat Products, Kohler Co., Acorn Engineering Company®, or approved.
- E. Shower Fittings: Acorn Engineering Company®, Bradley Corp., Fiat Products, or approved.
- F. Shower Heads/Faucets: Acorn Engineering Company®, Bradley Corp., or approved.

- G. Drinking Fountains and Electric Water Coolers: Elkay Mfg. Co., Haws Corporation, Halsey Taylor, Oasis International, Acorn Engineering Company®, or approved.
- H. Emergency Fixtures: Chicago Faucets, Co., Haws Corporation, Bradley Corp., Guardian Equipment, Acorn Engineering Company®, Speakman Company, or approved.
- I. Hose Bibbs and Wall Hydrants: Acorn Engineering Company®, Chicago Faucets Co., Jay R. Smith Mfg. Co., Wade, Woodford Manufacturing Company, Murdock Manufacturing Inc., or approved.
- J. Service Outlets: Guy Gray™, Jones Stephens Corp. (PlumBest), or approved.
- K. Faucets for Lavatories, Sinks and Service (Mop) Sinks: American Standard, Kohler Co., Delta Faucet Co., Elkay Mfg. Co., Just Manufacturing, Moen Commercial Div, Grohe, Chicago Faucets Co., Speakman Company, Leonard Valve Co., or approved.
- L. Miscellaneous Fittings: BrassCraft Mfg. Co., T & S Brass & Bronze Works, McGuire Mfg. Co., or approved.
- M. Flush Valves for Water Closets and Urinals: Sloan Valve Co., Zurn Industries, Delany Products, or approved.
- N. Closet Seats for Water Closets: Church, Olsonite, Bemis Mfr. Co., Beneke, Kohler Co., or approved.
- O. Under-Sink Protection for Accessible Fixtures: Truebro® Lav Guard®, McGuire Mfg. Co. Pro Wrap, or approved meeting ASTM C1822 and ASME A112.18.9.

**2.02 PLUMBING FIXTURE TRIM, GENERAL**

- A. Fixture Color: White unless otherwise indicated in the Contract Documents.
- B. Exposed Metal Parts: Polished chrome plated finish.
- C. Stop Valves: Provide in water connections to fixtures, except where fitting has integral stops. BrassCraft KT series, loose key angle pattern, quarter turn with lock shield, brass construction with polished chrome plated finish.
- D. Rigid Risers: Chrome plated copper tubing with polished finish, 1/2 inch outside diameter.
- E. Flexible Risers: Stainless steel braided reinforced polymer tube rated for use in potable water system as flexible water connection in accordance with ASME A112.18.6, 1/2 inch outside diameter.
- F. Pipe Escutcheons: Include where pipe or other fitting enters wall at fixture. Comply with requirements in Section 232116.
- G. Lavatory Strainer and Tail Pieces: McGuire 155 Series or approved, stainless steel brass fitting with perforated grid strainer and 17ga seamless brass tailpiece.
- H. Sink Grid Strainer and Tail Pieces: McGuire 152 Series or approved, stainless steel brass fitting with perforated grid strainer and 17ga seamless brass tailpiece.

- I. Sink Basket Strainer and Tail Pieces: McGuire 151 Series or approved, stainless steel brass fitting with perforated grid strainer and 17ga seamless brass tailpiece.
- J. P-Traps: McGuire 8900 Series or approved, cast brass chrome plated body, with cleanout, 17 gage seamless chrome plated trap arm.
- K. Vacuum Breaker: Include on water supply to each fixture which has a water connection located below rim and for fixtures with faucets with threaded outlets for hose attachment, flow-through pattern.
- L. Trap Primers: Provide for floor receptors unless trap seals are specified in Section 221300.
- M. Exposed Supplies: Provide escutcheon, stop valve, and vertical rigid risers as specified in this Section.
- N. Concealed Supplies: Provide escutcheon, stop valve, and vertical flexible risers as specified in this Section.
- O. Under-Sink Protection for Accessible Fixtures:
  - 1. Description: Fully molded flexible vinyl insulation kit for drain piping, P-trap, and hot and cold water supplies under lavatory to meet American with Disabilities Act (ADA) requirements.
  - 2. Rating: UL listed in accordance with ADA.
  - 3. Components: Smooth exterior conforming to pipe and fittings, hidden fastening system, removable trap cleanout cover, and hinged cap at stop valves to allow quick access with snap closure.

## 2.03 WATER CLOSETS

- A. WC-1 Water Closet (ADA Compliant):
  - 1. Description: Kohler Model K-84325, flush valve (ADA accessible), white vitreous china, elongated bowl, comfort height, 1.28 gallon per flush, polished chrome trip lever.
  - 2. Components:
    - a. Seat: Kohler Model 4650, self-sustaining check hinge with stainless post, no cover, open front.
    - b. Exposed supply.
    - c. Flush Valve: Royal std, 111-1.28, manual.
- B. WC-2 Water Closet:
  - 1. Description: Kohler Model K-84325, flush valve (ADA accessible), white vitreous china, elongated bowl, comfort height, 1.28 gallon per flush, polished chrome trip lever.
  - 2. Components:
    - a. Seat: Kohler Model 4650, self-sustaining check hinge with stainless post, no cover, open front.
    - b. Exposed supply.
    - c. Flush Valve: Royal std, 111-1.28, manual.

2.04 URINALS

A. UR-1 Urinal (ADA Compliant):

1. Description: Kohler Branham Model K-4920-T, wall mount, flush valve (top spud), washout stall, white vitreous china. Refer to architectural drawings for mounting height.
2. Flush Valve: Ryal std. 186, manual

2.05 LAVATORIES

A. L-1 Lavatory (ADA Compliant):

1. Description: Kohler Bolero K-2611-SU. Oval basin, satin finish, no faucet holes, requires counter for undermount installation. 20 GA stainless steel.
  - a. Faucet: Chicago Faucets Model 802-336, deck mounted, 4" integral spout, 336 indexed push-tilt handles.

2.06 SINKS

A. S-1 Sink, Single Bowl (ADA Compliant):

1. Description: American Elkay DLR222210, deck mounted, 18 gauge, type
2. 304 (18-8) nickel bearing stainless steel. Self-rimming. Refer to architectural drawings for mounting height.
3. Components:
  - a. Faucet: Chicago Faucets Model 201-a317, chrome plated, deck mounted concealed mixing faucet ceramic cartridges, 5-3/8 inch rigid/swing gooseneck spout 9-5/8 inch high, aerator, 4 inch wrist blade handles with indexes, 4 inch centers.
  - b. Trim: Provide drain, tailpiece, P-trap, grid strainer, and exposed supplies as specified in this Section.

B. TS-1 Sink, Triple Utility:

1. Description: Just Model NSFB360-24RL-J type 304 14 gauge stainless steel, 108 inch x 27-1/2 inch x 14 inch floor mount triple scullery sink with left and right drainboards and coved corners. Provide hole punching over partitions with (3) holes on 4 inch centers over each partition.
  - a. Faucet: Chicago Faucets Model 201-a317, chrome plated, deck mounted concealed mixing faucet ceramic cartridges, 5-3/8 inch rigid/swing gooseneck spout 9-5/8 inch high, aerator, 4 inch wrist blade handles with indexes, 4 inch centers.
  - b. Trim: Provide drain, tailpiece, P-trap, basket strainers, and exposed supplies as specified in this Section.
  - c. Emergency Eye Wash (EMEW-1): sink mounted, Type 316 stainless steel, chrome plated brass assembly, corrosion resistant, swing down valve operation, polypropylene spray heads with flip-top dust covers connected to swivel arm, internal flow control, in-line strainer. Include thermostatic mixing valve with dial thermometer as specified in Section 221120 and universal safety sign.

- C. SS-1 – Service Sink:
1. Fiat FL-1, Floor mounted service sink. 14 gauge type 304, 18-8 stainless steel. Interior surfaces Moldings are manufactured in matched metal dies under heat and pressure resulting in a homogeneous molded unit. Drain(s) with stopper(s) are furnished as standard equipment. Capacity shall be 17 gallons for the single tub sink and 33 gallons for the double tub sink. Laundry sinks available in white only.
  2. Trim: Provide drain, tailpiece, P-trap, basket strainer, and exposed supplies as specified in this Section.

## 2.07 SERVICE (MOP) SINKS

- A. MS-1 Service (Mop) Sinks:
1. Description: Fiat Model MSB- 2424,. floor mount, 24 inch long by 24 inch wide by 10 inch deep, molded stone with 1 inch wide shoulders.
  2. Components:
    - a. Faucet: Chicago Faucets Model 897-CCP, with 2 offset inlet supply arms and 2 inlet adapters, wall mounted, manual mixing type with integral stops and check valves, polished chrome plated solid brass, 8 inch centers, integral 8 inch spout, pail hook, adjustable wall brace with oval flange, male hose threaded outlet, integral stop valves, and atmospheric vacuum breaker, 2-3/8 inch metal handles, adjustable supply arms, integral drain.
    - b. Hose and Hose Brackets: Fiat 832-AA, 30 inch long flexible hose.
    - c. Mop Hanger: Fiat 889-CC, 24 inch by 3 inch.
    - d. Strainer: Fiat 1453-BB, flat stainless steel.
    - e. Vinyl Bumper Guard: Fiat E-77-AA.
    - f. Silicone Sealant: Fiat 833-AA.

## 2.08 SHOWERS

- A. SH-1 Shower Trim (ADA Compliant):
1. Description: Acorn 410BF Series – Apex type 1, Flush Mounted Barrier Free Showers. Install in tile showers. See architectural for locations and mounting heights.
    - a. Control Valve body is heavy cast bronze and all wearing parts are contained in a replaceable cartridge. Exposed surfaces are either polished stainless steel or triple chrome plated. All exposed fasteners are tamper resistant.
    - b. Shower Head is an Acorn Logan Wizard Shower Head with square mounting flange and is regularly furnished front drilled with stainless steel tamper-resistant screws. Connection to the water supply is made via an exclusive O-ring adapter, for back inlet shower heads.
- B. SH-2 Shower Trim:
1. Description: Acorn Shower-Ware 500 Series Model 515-GX-A – Zenith Built in showers. Install in tile showers. See architectural for locations and mounting heights.
    - a. Control Valve body is heavy cast bronze and all wearing parts are contained in a replaceable cartridge. Exposed surfaces are either polished stainless steel or triple chrome plated. All exposed fasteners are tamper resistant.

- b. Shower Head is an Acorn Logan Wizard Shower Head with square mounting flange and is regularly furnished front drilled with stainless steel tamper-resistant screws. Connection to the water supply is made via an exclusive O-ring adapter, for back inlet shower heads.

## 2.09 ELECTRIC WATER COOLERS

### A. EWC-1 Electric Water Cooler, 2 Level (ADA Compliant):

1. Description: Elkay Model LZWS-LRPBM28K, wall hung, dual-purpose unit for standing and wheelchair use, fully assembled.
2. Construction: Features shall include Antimicrobial\*, Filtered, Green Ticker™, and Free, Laminar Flow, Real Drain, Visual Filter Monitor. Furnished with Flexi-Guard® Safety Bubbler. Electronic Bottle Filler Sensor with Mechanical Front bubbler Button activation.
3. Components:
  - a. In-wall carrier mounting plate.
  - b. Water supply in-line filter.
  - c. Trim: Provide p-trap and concealed supply as specified in this Section.

## 2.10 EMERGENCY FIXTURES

### A. EMEW-1 Deck Mount, Emergency Eye/Face Wash:

1. Description: Chicago Faucets Model 9004-RH, deck mount, left hand, push paddle handle, and dual ABS spray heads with covers. Comply with ANSI/ISEA Z358.1.
2. Construction: ABS plastic spray head with cover, chrome plated ball valve with paddle handle and pipe and fittings.
3. Accessories: Thermostatic mixing valve as specified in Section 221120 and universal safety sign.

## 2.11 HOSE BIBBS AND WALL HYDRANTS

### A. WH-1 Exterior Wall Hydrant, Exposed:

1. Description: Woodford Model 65, non-freeze wall hydrant, exposed, brass valve body with hose end, ASSE 1011 anti-siphon vacuum breaker, automatic draining, loose key, wall clamp, 3/4 inch inlet. Stem length to suit wall thickness.

### B. HB-1 Interior Hose Bibb, Recessed:

1. Description: Woodford Model B24, recessed box type, chrome brass body with hose end ASSE 1011 anti-siphon vacuum breaker, removable wall flange and door with cylinder lock, loose key wheel handle, 3/4 inch inlet and outlet.

## 2.12 SERVICE OUTLETS

### A. SB-1 Ice Maker Water Service Box:

1. Description: Guy Gray Model BIM875, recessed 20 gage galvanized steel wall box with 1/2 inch inlet and 1/4 inch angle supply valve, 20 gage galvanized steel cover.

- B. WB-1 Clothes Washer:
1. Description: Guy Gray Model W B200, recessed 20 gage galvanized steel wall box with single lever arrester valve and 3/4 inch hose bibbs, right 2 inch drain, 20 gage galvanized steel cover.

### 2.13 FIXTURE SUPPORTS

- A. Water Closet Carriers:
1. Concealed cast iron carrier, vertical or horizontal adjustable pattern. Furnish type as required to fit within available wall space. Where wall space is restricted, vertical non-adjustable pattern carriers acceptable.
  2. Include support feet set on sub-floor or cast in sub-floor.
  3. Include brass fixture attachment bolts with double nuts and chrome-plated acorn type nuts.
  4. Include epoxy bolts for bariatric and wall mounted water closets. Lag bolts not acceptable.
- B. Wall Hung Fixtures other than Water Closets:
1. Concealed fixture hanger constructed for fixture.
  2. Include cast iron feet set on sub-floor, cast in sub-floor, or supported by floor-to-ceiling pipes.
  3. include concealed arm fixture supports where suitable for fixture.
- C. Manufacturers: Jay R. Smith, Wade, Josam, Zurn, Watts, or approved.

### 2.14 THERMOSTATIC MIXING VALVES, SINGLE

- A. Comply with requirements in Section 221120.

### 2.15 THERMOSTATIC MIXING VALVES, EMERGENCY FIXTURES

- A. Comply with requirements in Section 221120.

### 2.16 WALL AND FLOOR SEALANT

- A. Manufacturer and Type: Color to match fixture. General Electric No. 1200 Silicone Building Sealant, Dow Corning No. 780 Construction Sealant, or approved.

## PART 3 - EXECUTION

### 3.01 PRE-INSTALLATION REVIEW

- A. General: Verify installation conditions as satisfactory to receive the Work of this Section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.
- B. Before plumbing fixture installation, review in accordance with manufacturer's rough-in instructions for water, soil, and waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated. Use manufacturer's rough-in data.

- C. Examine walls, floors, and cabinets for suitable conditions where fixtures will be installed.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this Section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this Section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Do not cover up or enclose work until inspected and approved by the AHJ. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

### 3.04 PLUMBING FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions. Refer to architectural drawings for mounting heights.
- B. Wall-Hung Fixtures: Install with off-floor supports affixed to building substrate, anchored to allow no movement.
- C. Floor-Mounted Fixtures:
  - 1. Install on closet flanges or other attachments to piping or building substrate.
  - 2. Install back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- D. Counter Mounted Fixtures: Install and attach to casework.
- E. Install water supply piping with stop valve on each supply to each fixture to be connected to water distribution piping. Include separate stop valve for fixture accessories such as bubbler. Attach supplies to supports or substrate within pipe spaces behind fixtures.
- F. For fixtures without integral traps, install trap and waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- G. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- H. Install toilet seats on water closets.
- I. Install faucet spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- J. Install water supply flow control fittings with specified flow rates in fixture supplies at stop valves.



- K. Install faucet flow control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- L. Install shower, thermostatic mixing valve as specified in Section 221120, and shower head.
- M. Install dishwasher air gap fitting at each sink indicated to have air-gap fitting. Install on countertop at sink. Connect inlet hose to dishwasher and outlet hose to disposer.
- N. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with requirements in Section 232116.
- O. Seal joints between fixtures and walls, floors, and counters with wall and floor sealant.
- P. Trap Insulation for Accessible Fixtures: Install on exposed drain pipes, traps, tailpieces, waste arm, and on exposed hot and cold water piping stops and supplies. Install per manufacturer's recommendations with fasteners located out of sight for clean appearance.
- Q. Install frost proof wall hydrants 36 inch above finished grade.

**3.05 PLUMBING FIXTURES, FITTINGS, AND TRIM CONNECTIONS**

- A. Piping installation requirements are specified in Sections 221116 and 221300. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot and cold water and soil, waste, and vent piping to plumbing fixtures. Comply with equipment manufacturer's installation instructions.
- C. Install supplies, stop valves, pressure reducing valves, and similar devices as required between kitchen plumbing fixtures and rough-in plumbing for a complete installation. Obtain kitchen plumbing fixture rough-in drawings prior to installation.
- D. Water, Waste, and Vent Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use fittings required to match fixtures and equipment. Connect to plumbing piping.

**3.06 FIELD QUALITY CONTROL**

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

**3.07 ADJUSTING**

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Operate and adjust disposers, insta-hot dispensers, and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets, shower valves, and flush valves to produce proper flow and stream.
- D. Adjust shower valve limit stops per manufacturer's installation instructions. Read hot water temperature after adjustment of limit stops to ensure maximum 110 F to 115 F water temperature.
- E. Replace washers and seals of leaking and dripping faucets and stops.
- F. Test and balance trap primer systems as specified in Section 221116. Arrange piping to achieve equal flow to each floor receptor.

**3.08 CLEANING**

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Perform the following:
  - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
  - 2. Remove sediment and debris from drains.
  - 3. Remove labels.

**3.09 PLUMBING SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

**3.10 COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**3.04 INSTALLATION OF WATER HEATERS**

- A. General: Install within sheet metal drain pan.
- B. Seismic Restraint: Anchor or strap to wall to resist horizontal displacement due to earthquake motion. Locate straps in accordance with local code requirements.
- C. Components: Install as indicated on the Drawings.
- D. Electric Water Heaters: Install on an incompressible, insulated pad with a minimum thermal resistance of R-10.

**3.05 START-UP SERVICES**

- A. Equipment manufacturer's authorized representative shall perform start-up services of water heaters and related appurtenances. Services shall include a check of proper installation, system check-out, adjustment, and complete start-up. Start-up by the Contractor not acceptable.

**3.06 PLUMBING SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

**3.07 COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 05 00  
GENERAL PROVISIONS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing, and operation of mechanical work. This section applies to all Divisions 21, 22, and 23 sections.
- B. General Requirements: General Conditions, Supplementary Conditions, and Division 01 sections apply to the Work in this section.

**1.02 CODES AND STANDARDS**

- A. Perform work in accordance with requirements in the state in which the work is performed.
- B. Conform to applicable industry standards, such as UL and ETL standards, ANSI standards, and other standards as noted.
  - 1. Notify the A/E of deviations in the Contract Documents to applicable codes and ordinances prior to installation of the Work. Perform changes in the Work after initial installation due to requirements of code enforcing agencies at no additional cost to the Owner.
  - 2. If conflict occurs between legally adopted codes and the Contract Documents, the codes prevail, except that this shall not be construed as relieving the Contractor from complying with requirements of the Contract Documents which may exceed code requirements and not contrary to same.
  - 3. Arrange for and pay for required permits, fees, and inspections.
  - 4. Pressure Vessels and Relief Valves: Select, build, install, and label in accordance with state requirements and applicable ASME code. Frame and mount a certificate showing approval under this law adjacent to each pressure vessel and relief valve. Pay costs and fees for certificates, inspections, filing, and labeling.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and with additional requirements indicated in this article.
- B. Electronic Product Data:
  - 1. Comply with requirements in Section 013300 and additional requirements indicated in this article.
  - 2. Submit each specification section complete at one time with a dedicated submittal number for each section. For example, submit products for Section 233300 under one submittal number and products for Section 230900 under a different submittal number. Submitting multiple sections at one time acceptable as long as each section has a dedicated submittal number. Include submittal number and date submitted in file name.

3. Partial Product Data submittals for a specification section not acceptable and will be returned without review:
  - a. Sections 233100, 233300, and 233400 including products and materials for first submittal and the Shop Drawings for second submittal.
  - b. Section 230900 including products and materials for first submittal and the Shop Drawings for second submittal.
  - c. Sections 230548 and 230550 including products and the Shop Drawings that are contingent upon approval of specified products.
  - d. Sections 211000 and 213000 including products and materials for first submittal and the Shop Drawings for second submittal.
  - e. Long lead items.
  - f. Site and underground work.
4. Clearly mark catalog pages, equipment, and model number to be used. Indicate associated specification section and paragraph number on each page. Identify required options and accessories.
5. Format:
  - a. Adobe PDF file format.
  - b. Bookmark each submittal to facilitate browsing to each specification paragraph number.
  - c. Include table of contents for each specification section. Include catalog numbers or drawing numbers.
  - d. Include the Contractor and manufacturer's representative contact information for each product. Include job name (or abbreviation of job name), specification number, and contractor submittal number in file name.

C. Shop Drawings:

1. Submit 2D shop drawings for systems specified in Divisions 21, 22, and 23.
2. Submit prior to starting fabrication and installation work. Do not fabricate or install until reviewed by the A/E. Include complete location dimensions, hanger and support sizes and dimensions.
3. Complete drawings in timely manner and coordinate with construction schedule.
4. "Typical" drawings and wiring diagrams not acceptable unless they specifically apply to this project.
5. Show required coordination with work of other trades including electrical conduits, cable trays, structure, lighting fixtures and other items to be installed in ceilings, full height walls, and other items necessary to coordinate installation.
6. Floor plan backgrounds are available in electronic format and shall be requested from the A/E.
7. Direct use of the Drawings as the basis of the Contractor's prepared Shop Drawings not acceptable.
8. Format:
  - a. 2D drawings using industry recognized software for systems and areas of the building.
  - b. Minimum scale 1/4 inch per foot on same size sheets as the Drawings.
  - c. Adobe PDF file format.

9. Content:
- a. Fire Protection: Complete fire suppression installation consisting of detailed fire suppression drawings. Comply with requirements in 211000 and 213000.
  - b. Plumbing: Complete plumbing installation consisting of detailed piping drawings. Show piping, valves, thermal expansion loops, equipment, hangers, seismic bracing, vibration isolation, and other HVAC components included in the Contract Documents. Indicate sizes of piping, installed piping bottom of piping (BOP) above finished floor, equipment dimensions, dimensioned location of equipment and height above finished floor, slope of piping where applicable, and equipment tags.
  - c. Airside HVAC: Complete duct installation consisting of detailed sheet metal drawings. Show ducts, duct fittings, turning vanes, air devices, flexible ducts, volume dampers, motorized dampers, backdraft dampers, hangers, supports, seismic bracing, vibration isolators, equipment and other HVAC components included in the Contract Documents. Indicate sizes of ductwork, installed ductwork bottom of duct (BOD) above finished floor, equipment dimensions, dimensioned location of equipment and height above finished floor, air device tags indicating same information included on the Drawings, and equipment tags.
  - d. Wetside HVAC: Complete pipe installation consisting of detailed piping drawings. Show piping, valves, equipment, hangers, seismic bracing, vibration isolation, and other HVAC components included in the Contract Documents. Indicate sizes of piping, installed piping bottom of piping (BOP) above finished floor, equipment dimensions, dimensioned location of equipment and height above finished floor, slope of piping where applicable, and equipment tags.
  - e. HVAC controls: Complete controls installation consisting of detailed controls drawings. Comply with requirements in Section 230900.
- D. Approval: Approval of manufacturer's name or Product by the A/E does not relieve the Contractor of responsibility for providing materials and equipment which comply in detail with requirements of the Contract Documents.
- E. Re-Submittals: Clearly identify re-submittals. Provide revised tabs, indexes, page renumbering, and other formats to interface with original submittal. Identify changes and include date for project tracking.
- F. Test Reports and Certificates: Submit as package prior to Substantial Completion.
- G. Testing and Balancing Reports: Submit as indicated in Section 230593.
- H. Certifications: Submit written certifications from governing building authorities stating that the Work has been inspected and accepted, and complies with applicable codes and ordinances.
- I. Record Drawings: Comply with Article "Record Drawings" in this section.
- J. Commissioning: Submit equipment start-up and test procedures and preliminary Operations and Maintenance Manuals to the A/E as specified in Section 230820. Submit under separate bound cover.

1.04 SCHEDULE OF VALUES

- A. Comply with requirements in Division 01 with additional requirements as indicated in this article.
  
- B. Include labor and material costs as follows:
  - 1. Permit, Mobilization, Submittals, and Bond.
  - 2. Trailer, Services, Cranes, and Rentals.
  - 3. Foreman/Non-Labor.
  - 4. Fuel Costs.
  - 5. Project Closeout and System Startup.
  - 6. Punchlist.
  - 7. Record Drawings.
  - 8. Basic Materials and Methods.
  - 9. Electrical Provisions.
  - 10. Mechanical Systems Commissioning.
  - 11. Systems Training.
  - 12. Systems Operations and Maintenance Manuals.
  - 13. Fire Suppression Engineering and Shop Drawings.
  - 14. Wet Pipe System, Labor.
  - 15. Wet Pipe System, Material.
  - 16. Fire Pump, Labor.
  - 17. Fire Pump, Material.
  - 18. Testing, Adjusting, and Balancing.
  - 19. Mechanical Insulation, Labor.
  - 20. Mechanical Insulation, Material.
  - 21. Domestic Water, Labor.
  - 22. Domestic Water, Material.
  - 23. Plumbing Valves, Labor.
  - 24. Plumbing Valves, Material.
  - 25. Plumbing Pumps Labor.
  - 26. Plumbing Pumps, Material.
  - 27. Soil, Waste, Vent, and Storm Drain Piping Systems, Labor.
  - 28. Soil, Waste, Vent, and Storm Drain Piping Systems, Material.
  - 29. Interceptors and Separators, Labor.
  - 30. Interceptors and Separators, Material.
  - 31. Compressed Air Piping System, Labor.
  - 32. Compressed Air Piping System, Material.
  - 33. Plumbing Equipment, Labor.
  - 34. Plumbing Equipment, Material.
  - 35. Plumbing Fixtures, Labor.
  - 36. Plumbing Fixtures, Material.
  - 37. Indoor Air Quality.
  - 38. Piping Specialties, Labor.
  - 39. Piping Specialties, Material.
  - 40. Vibration Isolation, Labor.
  - 41. Vibration Isolation, Material.
  - 42. Seismic, Labor.
  - 43. Seismic, Material.
  - 44. Automatic Temperature Controls (ATC), Labor.
  - 45. Automatic Temperature Controls (ATC), Material.
  - 46. ATC Engineering and Shop Drawings.
  - 47. ATC, Commissioning.

48. ATC, Owner Training.
49. Refrigerant Piping, Labor.
50. Refrigerant Piping, Material.
51. Air Distribution, Labor.
52. Air Distribution, Material.
53. Air Distribution Accessories, Labor.
54. Air Distribution Accessories, Material.
55. Air Distribution Equipment, Labor.
56. Air Distribution Equipment, Material.
57. Air Devices, Labor.
58. Air Devices, Material.
59. Filters, Labor.
60. Filters, Material.
61. Packaged HVAC Equipment, Labor
62. Packaged HVAC Equipment, Material.
63. Terminal Heat Transfer Equipment, Labor.
64. Terminal Heat Transfer Equipment, Material.

#### 1.05 DEFINITIONS AND ABBREVIATIONS

- A. Refer to Division 01 sections for definitions and abbreviations. Additional definitions and abbreviations are as follows.
- B. “Approved” or “Approval” means written approval by the Owner or “Owner’s agent” (A/E).
- C. “Codes” means the AHJ adopted codes, rules, and ordinances and additional codes as specified herein.
- D. “Concealed and Concealed Work” means Work installed in spaces out of sight. For example, above ceilings, below floors, between double walls, within furred-in areas, within pipe and duct shafts, behind cabinets, and similar locations and spaces not exposed to view.
- E. The word “Contractor”, as used in Divisions 21, 22, and 23 sections, means fire suppression, plumbing, or HVAC subcontractor.
- F. “Coordination”, “Coordinating”, and “Coordinate” mean to bring, or bringing, into common action, movement, or combination so as to act together in smooth concerted way.
- G. “Directed”, “Requested”, “Accepted”, and similar terms mean these terms imply “by the A/E” unless otherwise indicated.
- H. “Exposed” means open to view of occupants in normally occupied areas. Work installed in mechanical, electrical, and equipment rooms is defined as exposed. Likewise for Work installed within accessible air distribution plenums, pipes installed in tunnels, and pipes installed in a room not covered by other construction.
- I. “Furnish” means supply and deliver to Project site ready for unloading, unpacking, assembly, installation, and similar activities.
- J. “Indicated” and “Indicated on the Drawings” means shown on the Drawings by notes, graphics or schedules, or written into other portions of the Contract Documents. Terms such as “shown”, “noted”, “scheduled” and “specified” have same meaning as “indicated”, and are used to assist reader in locating particular information.



- K. "Install" means to place in position for service or use. Includes operations at Project site, such as unloading, unpacking, assembly, erection, placing, preserving, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar activities.
- L. "Mechanical Rooms" mean such spaces as mechanical rooms, accessible mechanical attics, mechanical mezzanines, boiler rooms, and other type of rooms and spaces that house mechanical and plumbing equipment. This definition applies to multiple specification sections and as noted as room names on the Drawings.
- M. "Provide" means furnish and install for complete, finished, and operable system and ready for intended use.
- N. "Shop Drawings" means documents which fully detail equipment and intended installation relative to this specific Project.
- O. "Substantial Completion" shall mean that entire project (or readily definable portion thereof if so designated in the Contract Documents) is acceptable to code enforcement authorities and to extent required by such authorities, has been inspected and approved by such authorities, and is suitable for occupancy by the Owner or occupant for purpose intended. Refer to Divisions 00 and 01 sections for additional requirements.
- P. "Work" or "Project" means entire scope of work required by the Contract Documents.
- Q. Abbreviations:
- |        |  |
|--------|--|
| A/E    | Architect  |
| AHJ    | Authorities Having Jurisdiction  |
| AMCA   | Air Movement and Control Association   |
| ANSI   | American National Standards Institute  |
| ARI    | Air Conditioning and Refrigeration Institute                                   |
| ASHRAE | American Society of Heating, Refrigerating & Air Conditioning Engineers        |
| ASME   | American Society of Mechanical Engineers                                       |
| ASTM   | American Society for Testing and Materials                                     |
| AWS    | American Welding Society   |
| C      | Degrees Celsius  |
| CISPI  | Cast Iron Soil Pipe Institute  |
| CSA    | Canadian Standards Association   |
| ETL    | Environmental Technology Laboratory  |
| F      | Degrees Fahrenheit   |
| FM     | Factory Mutual   |
| FOIC   | Furnished by Owner Installed by Contractor                                     |
| HVAC   | Heating, Ventilating, and Air Conditioning                                     |
| IAPMO  | International Association of Plumbing and Mechanical Officials                 |
| IBC    | International Building Code  |
| IFC    | International Fire Code  |
| IFGC   | International Fuel Gas Code  |
| IMC    | International Mechanical Code  |
| IPC    | International Plumbing Code  |
| LEED   | Leadership in Energy and Environmental Design                                  |
| MERV   | Minimum Efficiency Reporting Value   |
| MSS    | Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. |
| NEC    | National Electrical Code, NFPA 70 (latest adopted edition with Amendments)     |
| NEMA   | National Electrical Manufacturer's Association                                 |
| NFPA   | National Fire Protection Association   |
| NSPC   | National Standard Plumbing Code  |
| OSHA   | Occupational Safety and Health Administration                                  |

PSI	Pounds per square inch
PSIG	Pounds per square inch gage pressure
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
UL	Underwriters Laboratories Inc.
UPC	Uniform Plumbing Code
V	Volts
WOG	Water Oil Gas
WSP	Working Steam Pressure

#### 1.06 MATERIALS

- A. Where two or more manufacturers are listed, select for use any of those listed. The first mentioned, in general, was used as basis of design. Bids on any manufacturer named acceptable as long as that manufacturer meets every aspect of the Contract Documents. Where several manufacturers are specified by name for one use, select for use any of those specified. Note that equipment layout is based on equipment listed in equipment schedules.
- B. Ensure that equipment will fit within available space. Where other than basis of design manufacturer is selected for the Project, the Contractor is responsible for verifying equipment will fit within available space and meet manufacturers and code required clearances.
- C. Where other than basis of design manufacturer is selected for the Project, include cost of resulting additional work, coordination with other trades, and redesign of associated building services and structure as required to accommodate selected equipment. Include redesign drawings with submitted Shop Drawings.
- D. Should any proposed Product require redesign work by the A/E to accommodate proposed Product, costs for such redesign work shall be included in the Bid amount. The Owner will compensate Engineer through the A/E at rate of \$175.00 per hour for time and expense for required review of submittals and additional coordination for redesign work. Amount of compensation will be deducted from Final Payment to the Contractor.

#### 1.07 STANDARDS OF QUALITY

- A. Equipment shall be manufacturer's regularly catalogued items and shall be supplied as complete unit in accordance with manufacturer's standard specifications and any optional items required for proper installation for equipment unless otherwise noted. Install equipment and materials in accordance with manufacturer's recommendations and best trade practices.
- B. Furnish products of single manufacturer for items which are used in quantity. A Product, for purpose of this paragraph, is assembly of components such as fans, air handling units, chillers, valves, and similar items. Materials such as pipe, fittings, pipe and duct insulation, and similar items not requiring maintenance are not included in single manufacturer requirement of this paragraph.
- C. Products shall be new unless indicated otherwise in the Contract Documents.

#### 1.08 SUBSTITUTIONS

- A. Comply with requirements in Division 01 with additional requirements indicated in this article.
- B. Substitutions will be considered following bid award only when a product becomes unavailable through no fault of the Contractor.

- C. Where “manufacturer” paragraphs include the words “or approved”, prior approval of the proposed substitution is required. The A/E is sole judge of quality of proposed substitution.
- D. When the A/E approves a substitution request, approval is given with understanding that the Bidder:
  - 1. Has investigated proposed Product and determined that it meets or exceeds quality level of specified Product.
  - 2. Will provide same warranty for substitution as for specified Product.
  - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to the Owner.
  - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
- E. Whenever a Product is described by detail, specification, trade name, manufacturer’s name or catalog reference, use only such Product, unless written approval is given for substitution prior to bid. Submit written requests on substitution request form included in Division 01. Approved substituted manufacturers will be listed by Addendum.
- F. Provide as specified certain products, materials, and systems where “manufacturer” paragraphs are followed by the words “No substitutions”.
- G. Substitutions will not be considered when they are indicated or implied on the Shop Drawings or product data submittals, without separate written prior approval, or when approval will require revision to the Contract Documents.

**1.09 DRAWINGS AND SPECIFICATIONS**

- A. General: Mechanical drawings are diagrammatic. Complete details of building features which affect fire suppression, plumbing, and HVAC installations may not be shown. For additional details, refer to other Contract Documents. Report any discrepancies to the A/E along with suggested revisions. Obtain written response from the A/E before proceeding with changes.
- B. Depiction of the Work: The Drawings do not show exact characteristics of the Work, piping and air distributions configurations, or necessary number of fittings and offsets. Base work on actual field measurements and conditions. Provide work required to complete installation.
- C. Dimensions: Do not scale drawings. Dimensional accuracy is not guaranteed, and field verification of dimensions, locations, and levels to suit field conditions is required.
- D. Discrepancies: Field verify dimensions and existing conditions prior to performing the Work. Bring to the A/E’s attention any discrepancies within the Contract Documents and between the Contract Documents and field conditions. Also, for any design and layout changes required due to specific equipment selection, prior to the Contractor’s work (equipment and material purchasing and installation). Any corrective work required by the Contractor after his discovery of such discrepancies, inconsistencies, or ambiguities shall be performed at no additional cost to the Owner.
- E. Specifications: These specifications are written in imperative mood and streamlined form. Imperative language is directed to the Contractor, unless specifically noted otherwise. The words “shall be” are included by inference where a colon (:) is used within sentences or phrases.

1.10 **RECORD DRAWINGS**

- A. Comply with requirements in Division 01, with additional requirements indicated in this article.
- B. Prepare Record Drawings. Record Drawings shall be new black line prints (pencil and black pen not acceptable) and shall show measured locations of portions of the Work and changes the Contractor has made.
- C. Record corrections and changes made during progress of the Work, showing work as actually installed. In general, acceptable tolerance plus or minus 1'-0" from actual location in horizontal plane. Indicate exact installed invert elevations for underground piping. Neatly hand-draft on daily basis. Keep readily available at project site. Use latest revisions and keep neat and clean. Do not use the Contractor's working drawings.
- D. Record Drawings are subject to review by the A/E on regular basis throughout construction. At end of construction, check drawings for completeness and accuracy.
- E. Drawings shall show addendum items, change orders, clarifications, supplemental instructions, and deviations from the Drawings.
- F. Per project closeout procedures, submit in AutoCAD format along with corrected black line drawings. Each sheet shall be noted as "RECORD DRAWING".

1.11 **COORDINATION**

- A. Coordinate Divisions 21, 22, and 23 Work with other trades.
- B. Be aware of restricted space for installation of fire suppression, plumbing, and HVAC systems. Include offsets and perform rerouting and coordination to fit elements in available space. Include provisions for such requirements in bid.
- C. Equipment, ductwork, and piping shown are based on existing drawings as available and on limited project site observations to extent possible under current conditions. Field verify existing conditions prior to commencement of Work. Obtain specific locations of structural and architectural features or equipment items from referenced drawings, field measurements, or trade providing material or equipment.
- D. Coordinate ductwork and piping installations to clear light fixtures and electrical cable trays. Include clearance over light fixtures to allow removal and replacement. Include minimum 6 inch clearance above and to sides of cable trays. Coordinate routing of ductwork and piping with each other and other trades so grade of piping can be accomplished and fit in available space.
- E. Coordinate clearance requirements with piping installation for piping insulation applications, duct installation for duct insulation applications, and equipment installation for equipment insulation applications. Before preparing piping and duct Shop Drawings, establish and maintain clearance requirements for insulation applications and field-installed insulation jackets and finishes and for space required for maintenance.
- F. Ductwork takes precedence over piping for available space and routing. Coordinate installation based on this precedence.

- G. Do not install ductwork and piping over electrical panels and where clearance is required by code and for maintenance.
- H. Be responsible for beam penetrations as they relate to fire suppression, plumbing, and HVAC work. Submit sizes and locations to structural engineer for review and determination of structural details.
- I. Coordinate attachments to structure to verify that attachment points on equipment and structure can accept seismic, weight, and other loads imposed.

**1.12 WORKMANSHIP**

- A. Work shall be in accordance with best trade practices. Remove substandard workmanship and provide new material at no additional cost to the Owner.

**1.13 HVAC SYSTEM USAGE**

- A. The Owner may give permission under the following minimum conditions. Other conditions will be determined by the A/E at time of HVAC system use.
  - 1. No use until sanding and painting is completed.
  - 2. Provide temporary filters and provide permanent filters at Substantial Completion of project. Comply with requirements in Section 234100 for filters during construction.
  - 3. Warranty commences at Substantial Completion regardless as to equipment warranty conditions.

**1.14 CERTIFICATION**

- A. By submitting a Bid for fire suppression, plumbing, and HVAC systems, the Contractor and his subcontractors acknowledge and certify the following:
  - 1. That they have carefully examined and fully understand the Drawings and Specifications including but not limited to architectural, site, utility, mechanical, structural, and electrical drawings, and their specifications. In addition, they have determined that the Drawings and Specifications are adequate to complete fire suppression, plumbing, and HVAC systems and that they can provide complete finished and operable system in accordance with the Contract Documents.
  - 2. That they have had reasonable opportunity to discover any ambiguities in the Contract Documents and such ambiguities have been brought to attention of the A/E in writing prior to submitting the Bid.
  - 3. That they have reviewed project progress schedule with general contractor, fully understand schedule, and they have verified, prior to submitting a Bid, availability of necessary labor and materials, including supervision and office backup, and can comply with schedule requirements.
  - 4. That there may be changes to scope of work and that they understand that any proposal submitted for performance of additional work shall include costs associated with such change including but not limited to labor, materials, subcontracts, equipment, taxes, fees, schedule impact, loss of efficiency, supervision, overhead, and profit.
  - 5. That the Contract requires them to coordinate their work with that of other trades and that responsibility for coordination includes rerouting, offsets, and similar provisions, to fit the Work and address manufacturer's recommended clearances for service access, maintenance, and replacement of equipment in manner that is compatible with the Work of other trades in same area.

6. That routing of elements of fire suppression, plumbing, and HVAC systems shown on the Drawings is schematic only and that offsets and rerouting will be required in installation and that labor and materials for offsets and rerouting have been included for such in their bids.
7. That they have consulted with affected utilities and included in their bids labor and materials to meet requirements which may be imposed by each utility and have included in their bids costs and fees to be paid to such utilities, including temporary services and temporary and permanent connections unless specifically excluded in the Contract Documents.
8. That they understand submittals of material and equipment to the A/E is for the purpose of establishing what they are providing for the Project. Any review undertaken by the A/E does not relieve them of their responsibilities to furnish and install materials and equipment required for the Work in the Project nor does such review relieve them of their responsibilities for coordination with other trades and designers to ensure that such materials and equipment will fit and be suitable for purpose intended.
9. That they agree to receive payment for bid amounts as full compensation for furnishing materials and labor which may be required in prosecution and completion of the Work required under the Contract Documents, and in respects to complete the contract work to satisfaction of the A/E.
10. That they include in their bids costs to furnish bonds as specified in the Contract Documents.

**1.15 WARRANTY**

- A. Conform to requirements in General Conditions, Supplementary Conditions, and Division 01. Where not so prescribed or defined, the period shall be 1 year. Warranty periods within Divisions 21, 22, and 23 shall not commence until Substantial Completion. Contractor shall extend longer warranties specified in other sections.

**1.16 EQUIPMENT FURNISHED BY OWNER INSTALLED BY CONTRACTOR (FOIC)**

- A. Material Handling and Delivery: Coordinate delivery of FOIC equipment. Receive, off load, transport, store, hoist, unpack, dispose of packing, same as for other project equipment arriving at job site. Requirements of the Contract Documents apply to FOIC equipment.
- B. Operations and Maintenance Data: Obtain from the Owner operations and maintenance data for FOIC equipment and incorporate them into the Operations and Maintenance Manuals.
- C. Start-up and Warranty:
  1. FOIC equipment suppliers will pass on to the Contractor start-up information, maintenance and parts information, and warranty provisions of their products in accordance with the equipment suppliers contract requirements. Organize and coordinate start-up and warranty requirements for FOIC equipment.
  2. Include one year warranty on FOIC equipment starting at Substantial Completion regardless of shorter time limits by FOIC suppliers.

**1.17 DEMONSTRATION**

- A. Comply with requirements in Division 01 with additional requirements indicated in this article.

- B. Following installation of fire suppression, plumbing, and HVAC work and prior to final acceptance, demonstrate that equipment and systems operate as indicated in the Contract Documents and in accordance with manufacturer's recommendations.
- C. Perform in presence of the A/E and the Owner's representative, unless otherwise directed by the A/E. Give minimum 1 week notice prior to demonstrations.
- D. Provide instruments and personnel required to conduct demonstrations.

**1.18 SUBSTANTIAL COMPLETION**

- A. Comply with requirements in Divisions 00 and 01.
- B. Prepare list of items that are not complete prior to asking for the Substantial Completion review by the A/E.
- C. Review of the Work: The A/E's fee for mechanical work includes 2 final construction observation reviews. First one is the Substantial Completion review of the Work and will be in response to the Contractor's notice of final completion of the Work. If necessary, second one is post-Substantial Completion review of the Work and will occur after notification by the Contractor that deficiencies noted during the Substantial Completion review have been corrected.
- D. Cost of Additional Reviews: If additional reviews by the A/E are required due to Contractor's failure to correct deficient work, the Owner will compensate the A/E on a time and expense basis at rate of \$175.00 per hour. Amount of additional compensation for additional reviews will be deducted from the Final Payment to the Contractor.

**1.19 ALTERNATES**

- A. General: See Bid Form and Alternates described in Division 01 for possible effect on work of Divisions 21, 22, and 23.

**1.20 COMMISSIONING**

- A. Comply with requirements in Sections 019113 and 230800.
- B. Submit equipment start-up and test procedures and preliminary Operations and Maintenance Manuals to the A/E as specified in Section 230820. Submit under separate bound cover.

**PART 2 - PRODUCTS**

Not used.

**PART 3 - EXECUTION**

Not used.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 05 05  
PROJECT CLOSEOUT AND SYSTEM START-UP**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes material and labor required to perform start-up of equipment and systems installed in project, to perform checkout of systems, and to verify completeness of project requirements.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 and Sections 230500, 230510, and 230593 apply to the Work in this section.
- C. Refer to requirements in Sections 230800 and 230512.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Submit within 8 weeks of award of Contract the following for review and approval by the A/E and Commissioning Authority.
  - 1. Checklist for each piece of scheduled equipment indicating items that will be verified for proper operation and completeness of installation. Include an area for comments and completion date for correction of deficiencies. Use of the equipment manufacturer's standard start-up/checkout form is acceptable.
  - 2. Checklist of controls by system or piece of equipment indicating items that will be checked, sequences that will be checked, and completeness of the installation. Include an area for comments and completion date for correction of deficiencies.
  - 3. Checklists shall have a place at each item for the person doing checkout to initial item indicating task has been completed and date it was completed.
  - 4. Preliminary schedule indicating sequence of events involved with pre-functional check-out, equipment start-up, testing and balancing (TAB), TAB verification, and functional testing. Schedule shall indicate approximate time intervals required for completion of respective tasks.
  - 5. Prepare and submit a list of items that are not complete prior to requesting substantial completion review by the A/E.

**PART 2 - PRODUCTS**

Not used.



PART 3 - EXECUTION

3.01 PROJECT CLOSEOUT PROCEDURES

- A. Complete the Work described in this section prior to time of Substantial Completion.
- B. Use pre-functional checklists prepared by Commissioning Authority to verify completeness of system installation and proper system operation. Submit completed checklists for review prior to Substantial Completion.
- C. Schedule pre-startup coordination meeting with the Architect, the Owner, and the Engineer and the Commissioning Authority for the specific purpose of achieving a coordinated systems start-up.
- D. Representatives for the mechanical subcontractor, plumbing subcontractor, sheet metal subcontractor, temperature control subcontractor and TAB subcontractor shall be present at the pre-startup meeting and at the initial startup of each mechanical system.
- E. Mechanical subcontractor shall bear prime responsibility for startup of heating and cooling and plumbing systems.
- F. If a piece of equipment is not performing satisfactorily during TAB, TAB subcontractor shall notify the installing subcontractor for corrective action.
- G. All subcontractors shall comply with the decision of the Construction Manager and the A/E of any conflict of responsibility.
- H. Include completed checklists in the Operation and Maintenance Manuals.

3.02 SYSTEM START-UP PROCEDURES

- A. As a minimum, the items listed in this article shall be completed. Include recommendations by manufacturers of systems and equipment.
- B. Inspect bearings for cleanliness and alignment and remove foreign materials found. Grease in accordance with manufacturer's recommendations. Replace bearings that run rough or noisy.
- C. Adjust tension in V-belt drives, adjust variable-pitch sheaves and drives for required equipment speed. Change belts and sheaves to obtain proper equipment speed, remove any foreign materials from sheaves and belts before starting operations, adjust drives for alignment of sheaves and V-belts. "Required equipment speed" is that speed which produces intended performance. Adjust fans and rotating equipment to maintain operation within the performance curve provided by manufacturer without over speeding equipment or causing excess vibration.
- D. Adjust direct drives for proper alignment of flexible couplings, lubricate particular couplings, check security of couplings to driver and driven shafts, and set drive components to ensure free rotation with no undesirable stresses on coupling and attached equipment.
- E. Check pump packing glands and mechanical seals for cleanliness and adjustment before running pump. Inspect shaft sleeves for scoring and proper placement of packing, replace if necessary. Inspect mechanical faces, chambers and seal rings. Replace if necessary. Ensure piping systems are free of dirt and scale before circulating liquid through pumps.

- F. Tighten flanges and packing glands after systems have been placed in operation. Replace gaskets in flanges that show signs of leakage after tightening.
- G. Inspect both manual and automatic control valves, clean bonnets and stems, tighten packing glands to ensure no leakage, but permit valve stems to operate properly. If leaking, replace packing in valves to retain maximum adjustment after system is judged complete. Replace packing in any valve that continues to leak after adjustment, remove and repair bonnets that leak, coat packing gland threads and valve stems with surface preparation similar to MolyCote or FelPro after cleaning.
- H. Inspect and make certain that automatic control valve seats are free from foreign material and are properly positioned for intended service.
- I. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts, apply compound and remake joint.
- J. Clean strainers, dirt pockets, orifices, valve seats and headers in fluid systems after systems have been placed in operation to ensure they are free from foreign materials.
- K. Adjust pipe hangers and supports for correct pitch and alignment.
- L. Remove rust, scale and foreign materials from equipment and renew any defaced surfaces. If equipment is badly marred, the A/E has authority to require new materials be provided.
- M. Install clean air filters. Refer to requirements in Section 234100.
- N. Inspect pressure gages and thermometers for calibration. Remove and provide new for those that are defaced, broken, or read incorrectly.
- O. Repair damaged insulation.
- P. After each system has been put into operation, repeat certain checks described in preceding paragraphs.
- Q. Complete applicable start-up procedures described in preceding articles and paragraphs prior to Substantial Completion.
- R. Provide adjustment services as necessary to ensure proper functioning of systems after building occupancy and during warranty period.

### 3.03 SCHEDULE OF VALUES

- A. Include a line item in schedule of values for doing the project closeout and system start-up work. Value shall include the time for preparing initial checklists, for checking out project, and for starting up systems. Value shall accurately reflect amount of time and material Contractor estimates to spend on these tasks.

### 3.04 FINAL ACCEPTANCE

- A. Final acceptance of the Work will not occur until functional testing is complete and outstanding issues resolved.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 05 10  
BASIC MATERIALS AND METHODS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes equipment supports, sleeves, identification, appurtenances, and miscellaneous work. This section applies to all Divisions 21, 22, and 23 sections.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. UL Compliance: Where UL fire-resistance rating is indicated for construction penetrated by access units, furnish UL listed and labeled units, except for those units which are smaller than minimum size requiring ratings as recognized by governing authority.
- C. Codes and Standards:
  - 1. ASME A13.1, Scheme for the Identification of Piping Systems for lettering size, colors and installed viewing angles of identification devices.
  - 2. ASTM D 709, Standard Specifications for Laminated Thermosetting Materials.
  - 3. ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>).
  - 4. ASTM D 2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
  - 5. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 6. ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
  - 7. NFPA 255, Surface Burning Characteristics Building Materials.
  - 8. UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.
  - 9. UL 1479, Standard for Fire Tests of Through-Penetration Firestops.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Equipment supports
  - 2. Sleeves
  - 3. Pipe markers and color bands
  - 4. Underground pipe markers
  - 5. Equipment nameplates
  - 6. Valve tags

- 7. Ceiling access doors
- 8. Roof penetrations
  
- C. Valve schedule for each piping system.
- D. Valve location drawings.
- E. Test Reports: As required in specific specification sections.

**1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products in accordance with manufacturer's recommendations, using means and methods to prevent damage, deterioration, and loss, including theft.
- B. Deliver products to site in manufacturer's original containers, complete with labels.
- C. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
- D. Store products subject to damage by weather conditions above ground, under cover in weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.
- E. Close open ends of equipment and work with temporary covers or plugs during storage and construction to prevent entry of foreign material.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Materials shall be new and of manufacturers specified herein. They shall bear the UL, ETL or CSA labels where possible.

**2.02 EQUIPMENT SUPPORTS**

- A. Select and size supports, expansion shells and bolts, concrete inserts, and anchor bolts per requirements for seismic restraints specified in Section 230550. Hot dipped or mechanically galvanized where installed outdoors unless noted otherwise on the Drawings. Damaged galvanized surfaces repaired with ZRC Worldwide Galvilite® Galvanizing Repair.
- B. Expansion Shells and Bolts and Concrete Screws:
  - 1. Manufacturers for Expansion Shells for Rod Hangers: Simpson Strong-Tie®, Hilti, or approved for holes drilled in concrete.
  - 2. Manufacturers for Expansion Bolts for Equipment: Simpson Strong-Tie®, Hilti, or approved for holes drilled in concrete.
  - 3. Manufacturers for Concrete Screws for Equipment: Simpson Strong-Tie®, Hilti, or approved for holes drilled in concrete.
- C. Concrete Inserts: Comply with requirements in Section 232116.

- D. Formed Steel Channels: Twelve gage minimum, 1-5/8 inch by 1-5/8 inch minimum cross-section size, epoxy coated. Cooper B-Line Dura-Green™ or Dura-Copper™, Unistrut, POWER-STRUT®, or approved.
- E. Rooftop Equipment Supports: Prefabricated, 18 gage galvanized steel, unitized construction, galvanized cap flashing, internal reinforcement, continuous welded corner seams, minimum 9-1/2 inch overall height. Top of support level where installed on sloped roofs. Roof Products & Systems Style ER-4A or approved.
- F. Anchor Bolts: Include for equipment. Number and size per manufacturer's recommendations or as indicated on the Drawings.
- G. Supplementary Steel Framing: Standard structural steel shapes or Schedule 40 steel pipe.
- H. Welding to Building Structural Members: Not acceptable except as indicated on the Drawings.
- I. Concrete Bases (Housekeeping Pads): Include bases under floor mounted equipment, nominal 3-1/2 inch high. Coordinate with Division 03. Size bases 4 inch larger than equipment footprint in each direction unless noted otherwise on the Drawings.

### 2.03 SLEEVES

- A. Materials, General: Schedule 40 galvanized steel pipe with unthreaded ends, cast iron pipe, or minimum 26 gage galvanized sheet steel. Use steel pipe for sleeves through floor slabs.
- B. Sleeves and Firestopping in Fire and Smoke Rated Walls and Floors:
  - 1. Sleeves: Same material and thickness as used when firestopping material was tested and as listed in the UL Fire Resistive Directory.
  - 2. Firestopping: Material produced and installed as a system to resist spread of fire and passage of smoke and to maintain fire resistance of assembly. Material in accordance with ASTM E 814 and UL 1479. Johns Manville, Dow Corning, 3M™ Fire Protection Products, Nelson Firestop Products, STI-SpecSeal®, US Gypsum, or approved.
- C. Cast-in-Place Watertight Firestop Device in Fire Rated Floors (Contractor Option): Factory assembled device for installation in concrete floors. Assembly in accordance with ASTM E 814 and UL 1479. Device consists of outer sleeve lined with intumescent sleeve, radial extended flange attached to one end of sleeve for fastening to concrete formwork, and waterstop gasket/mid-body seal for embedment and sealing to concrete slab. Nonmetallic sleeve for nonmetallic through-penetrant pipe and metallic sleeve for metallic through-penetrant pipe. Flame spread rating of 0 and smoke developed rating of 5. Presealed Systems, HOLDRITE® HydroFlame™ Sleeving Systems, or approved.
- D. Below Grade Watertight Wall and Slab On-Grade Floor Penetrations: Manufactured pipe-to-wall penetration closure. GPT Link-Seal®, Advance Products & Systems INNERLYNX®, Metraflex MetraSeals, Flexicraft Industries PipeSeal, or approved.
  - 1. Description: Modular mechanical type assembly consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and wall opening. Seal constructed to provide electrical isolation between pipe and wall, reducing cathodic reaction. Glass reinforced nylon pressure plates with zinc plated nuts and bolts.

2. Sleeves for New Construction: HDPE thermalplastic with full circle molded in waterstop plate and reinforcing ribs. Length to suit wall thickness. Inside diameter to suit seal requirements. Century-Line® Model CS.
3. Openings for Concrete Wall Construction or slab on grade floor penetrations: Core drill opening, inside diameter to suit seal requirement.

#### 2.04 PIPE MARKERS AND COLOR BANDS

- A. General: Manufacturer's standard preprinted, flexible or semi-rigid, permanent, color-coded, plastic sheet pipe markers. Comply with ASME A13.1 for label color and lettering size. Color code markers in accordance with Article "Pipe Markers and Color Bands Schedule" in this section. Include flow direction arrows.
- B. Small Pipes: For external diameters less than 6 inch (including insulation), full band pipe markers.
- C. Lettering: Indicate piping system using full name or abbreviation as indicated on the Drawings. Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance acceptable, as selected by the A/E in cases of variance with names indicated on the Drawings.
- D. Manufacturers: Seton, Brady Corp., Craftmark Pipe Markers, Marking Services Inc., or approved.

#### 2.05 UNDERGROUND PIPE MARKERS

- A. Manufacturer's standard, permanent, bright-burial service, not less than 6 inch wide by 4 mils thick. Tape color with printing which most accurately indicates type of service of buried pipe.

#### 2.06 EQUIPMENT NAMEPLATES

- A. General: Engraved stock melamine plastic laminate. Comply with ASTM D 709. Engraved with engraver's standard letter style of sizes and wording, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Plastic strips with raised letters made by a marking device not acceptable. Include area (room) served on nameplate. Coordinate naming convention with the Owner. Color of nameplates for access doors for fire dampers, smoke dampers, and combination fire/smoke dampers as selected by the AHJ.
- B. Thickness: 1/16 inch thick for nameplates up to 20 square inch or 8 inch length and 1/8 inch thick for larger nameplates.

#### 2.07 VALVE TAGS

- A. General: Manufacturer's standard solid plastic valve tags with printed enamel lettering, piping system abbreviation in approximately 3/16 inch high letters, sequenced valve numbers approximately 3/8 inch high, and 5/32 inch hole for fastener. Coordinate naming convention with the Owner.
- B. Valve Schedule: Typewritten on 8-1/2 by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (or as shown on tag), location of valve (room or space), and variation for identification (if any). Identify valves for emergency shutoff and similar uses in margin of schedule.

- C. Fasteners: Manufacturer's standard solid brass beaded type chain, length as required for proper attachment of tags to valves manufactured specifically for that purpose.
- D. Valve Schedule Frames: Glazed display frame with screws for removable mounting on masonry walls. Frame finished hardwood or extruded aluminum with SSB-grade sheet glass. Laminated plastic with reinforced mounting holes acceptable.

#### 2.08 VALVE LOCATION DRAWINGS

- A. General: Laminated plastic with reinforced mounting holes, 11 by 17 inch size, indicating locations of fire suppression, domestic water, natural gas, and hydronic shutoff valves on floor plan for each floor level. Color code valves for each system similar to pipe markers per Article "Pipe Markers and Color Bands Schedule" in this section. Include legend on each drawing.

#### 2.09 CEILING ACCESS DOORS FOR FIRE SUPPRESSION, PLUMBING, AND HVAC EQUIPMENT

- A. General: Universal 1-piece frame, flush type, welded steel ground smooth rounded safety corners, 1-piece spring hinge, slot screwdriver type cam latches, shallow 1-1/4 inch mounting flange. Include cylinder locked units in restrooms and areas accessible by students. Coordinate with general contractor so that lockable access doors are common-keyed for entire project. Where located in a painted surface area, units primed for painting; otherwise, polished chrome or stainless steel units, unless another type of finish is indicated.
- B. Construction:
  - 1. For sizes 16 inch by 16 inch and smaller: 16 gage panel, 18 gage flange.
  - 2. For sizes 18 inch by 18 inch and larger: 14 gage panel, 16 gage flange.
- C. Fire Rating: Where building fire-resistance rating is indicated, on the Drawings, doors shall be UL listed and labeled to meet fire rating requirements, except for those doors which are smaller than minimum size requiring fire ratings as recognized by governing authority.
- D. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 8 inch by 5 inch.
  - 2. Two-Hand Access: 12 inch by 6 inch.
  - 3. Head and Hand Access: 18 inch by 24 inch.
  - 4. Head and Shoulder Access: 24 inch by 24 inch.
  - 5. Body Access: 30 inch by 14 inch.
  - 6. Body plus Ladder Access: 36 inch by 24 inch.
- E. Manufacturers: Milcor, Elmdor, Acudor Products Inc., or approved.

#### 2.10 PERSONNEL PROTECTION

- A. General: Where support angles, hangers, equipment supports and appurtenances, and similar items are exposed above floors, walkways, and maintenance access ways, cover such protrusions less than 6'-6" above floor with protective padding.
- B. Protective Padding: Soft elastomeric foam material or equivalent with composite and component ratings per NFPA 255, ASTM E 84, or UL 723. Flame spread 25, smoke developed 50. Comply with requirements in Section 230700 for elastomeric insulation.

- C. Finish: White field-applied finish of same manufacturer as protective padding.

#### 2.11 PAINTING

- A. General: Painting of work specified in mechanical sections which is exposed, including exterior exposed mechanical work, is specified in Division 09.

#### 2.12 ROOF PENETRATIONS

- A. Dektite flashings (flexible rubber boot flashing) at pipe penetrations through steel or composition roofs.
- B. Use 4 pound per square foot seamless lead flashing skirt, minimum of 8 inch extending from pipe, with conical galvanized steel reinforcing boot and counterflashing fitting on built-up roofing.
- C. Pipe Curb Assembly: Consist of galvanized steel 12 inch high roof curb with cant strip, mitered corners, all welded construction, 1-1/2 inch thick rigid fiberglass insulation, 2 inch by 2 inch pressure treated wood nailer, and removable cover. The Pate Company Style CPBA Series cover with Style PCA-1 curb or approved.

### PART 3 - EXECUTION

#### 3.01 MEASUREMENTS

- A. Verify measurements at job site. Locate equipment and fixtures on centers of walls, openings, spaces, and similar locations except where noted otherwise. Check that piping, ducts, and similar elements clear openings.

#### 3.02 INSTALLATION OF EQUIPMENT

- A. Equipment Installation:
  - 1. General: Install supports for equipment and appurtenances.
  - 2. Suspended Equipment:
    - a. Install concrete inserts before concrete is placed. Fasten inserts securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.
    - b. Install hangers from structure. Comply with requirements in Section 232116 for hanger rod sizes.
    - c. Span between structural members with additional structural steel to mount equipment in locations shown. Do not fasten hangers to metal deck. Powder actuated fasteners not acceptable.
  - 3. Floor-Mounted Equipment, General:
    - a. Install machine and floor or foundation fastenings. Set equipment on concrete pads. For new construction, install anchor bolts through concrete equipment pads to structural concrete slabs. For existing construction, install concrete expansion anchors or concrete screws through concrete equipment pads to existing structural concrete slabs.



- b. Install equipment at locations and to dimensions indicated in the drawings using manufacturer's leveling screws, blocks, shims, or wedges. Do not distort equipment or baseplates.
  - 4. Stands: Fabricate structural steel stands to support equipment not floor mounted or suspended from structure. Fabricate from structural steel members or steel pipe and fittings.
  - 5. Manufacturer-Supplied Bases: Bases may be supplied by the equipment manufacturer if equivalent to base requirements specified above.
- B. Equipment Seismic Restraints: Comply with requirements in Section 230548.

### 3.03 SLEEVES AND SEALING OF SLEEVES

- A. Install sleeves for pipes and ducts for penetrations through cast-in-place concrete walls and floors, non-rated walls and floors, fire and smoke rated walls and floors, mechanical room walls and floors, and acoustical walls. Seal air and watertight. At Contractor's option, install cast-in-place watertight firestop devices through cast-in-place concrete fire rated floors.
- B. Dimensions:
  - 1. Annular Clear Space, General: Include annular clear space of approximately 1/4 to 1/2 inch. Size to accommodate insulation passing through sleeve.
  - 2. Annular Clear Space for Sleeves through Fire and Smoke Rated Walls and Floors: Include annular clear space between sleeve and insulated or uninsulated surfaces of pipe, tubing, conduit, and wiring per firestopping manufacturer's installation requirements. Coordinate with requirements in Division 07 and insulation thicknesses specified in Section 230700.
  - 3. Annular Clear Space for Sleeves through Mechanical Room Walls and Floor and Acoustical Walls: Comply with requirements in Section 230548.
  - 4. Cast-in-Place Watertight Firestop Devices: Match uninsulated through penetrant pipe outside diameter size.
- C. Setting: Set sleeves or cast-in-place watertight firestop devices in place prior to pouring of concrete in new construction. Core drill and grout sleeves in place for unit masonry construction. Core drill existing concrete wall and floor construction.
- D. Sealing of Sleeves:
  - 1. Through Walls and Floors: Fill both ends of sleeve with non-hardening silicone sealer as specified in Division 07.
  - 2. Through Fire and Smoke Rated Walls and Floors: Install firestopping material in accordance with manufacturer's installation requirements.
  - 3. Through Acoustical Walls: Comply with requirements in Section 230548.
- E. Below Grade Watertight Wall and Slab-On-Grade Floor Penetrations: Install manufactured pipe-to-wall penetration closures where pipes pass through openings for below grade walls or slab on-grade floors.

### 3.04 FLASHINGS AT ROOF PENETRATIONS AND ROOFTOP EQUIPMENT SUPPORTS

- A. General: Coordinate flashing for pipes, ducts, and conduits through roof surface and for equipment supports and similar items supported by or attached to roof deck with requirements in Division 07.

- B. Pipe Curb Assembly: Install per manufacturer's installation instructions. Fill curb with foam insulation.

### 3.05 ACCESSIBILITY

- A. General: Locate valves, dampers, controls, and similar components to be readily accessible. Install access doors to achieve accessibility. Access shall include, but not limited to, fire suppression, plumbing, and HVAC equipment above inaccessible ceilings and trap primers, valves, and similar items behind walls and above ceilings. Coordinate access door locations with the A/E.
- B. Equipment:
  - 1. Install equipment which requires periodic servicing or repairs to be readily accessible, except where specifically shown on architectural drawings. Otherwise, obtains A/E approval of location.
  - 2. Piping, ducts, and conduit shall not interfere with required access.
  - 3. Locate fire suppression, plumbing, and HVAC equipment above ceilings within 2 feet of access doors. If access to equipment is from bottom of unit, locate access door directly under unit sized large enough to accommodate access to internal components.
- C. Access Tile Identification: Apply circular dot stickers on ceiling grid frame to indicate location of valves, dampers, controls, and equipment that requires maintenance. Color as selected by the A/E.

### 3.06 PIPE MARKERS AND COLOR BANDS

- A. Install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Install to be visible on sides or bottom of pipe.
- B. Locate pipe markers and color bands as follows wherever piping is exposed in occupied spaces, accessible maintenance spaces, and exterior non-concealed locations.
  - 1. Near each valve and control device.
  - 2. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch where there could be question of flow pattern.
  - 3. Near locations where pipes pass through walls and floors/ceilings or enter non-accessible enclosures.
  - 4. At change in direction of pipe.
  - 5. At access doors, manholes and similar access points which permit view of concealed piping.
  - 6. Near major equipment items and other points of origination and termination.
  - 7. Spaced intermediately at maximum spacing of 30 feet along each piping run, except reduce spacing to 15 feet in congested areas of piping and equipment. Stagger alternately on adjacent pipes.
  - 8. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

**3.07 UNDERGROUND PIPE MARKER**

- A. During backfilling and placing of topsoil, install continuous marker tape located directly over buried line at 6 to 8 inch below finished grade for each exterior piping system. Where multiple small lines are buried in common trench that do not exceed overall width of 16 inch, install single line marker. For sewer drain fields and similar installations, mark only outer pipelines of field.

**3.08 PERSONNEL PROTECTION**

- A. General: Secure and permanently fasten elastomeric foam material in neat and smooth manner using band straps, clamps, snaps, or similar methods.
- B. Finish: Apply 1 or 2 coats to result in uniform white color.

**3.09 VALVE TAGS**

- A. Install valve tags on valves and control devices in each piping system. Install wherever destination or identity of pipe is not visible from valve. Fasten with chain to valve stem.
- B. Tags for check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, hose bibbs, wall hydrants, shutoff valves at HVAC terminal devices and similar rough-in connections of end-use equipment not required. Include tagged valves in valve schedule for each piping system.
- C. Install valve schedule in mechanical rooms and in custodial rooms or as directed by the A/E.

**3.10 VALVE LOCATION DRAWINGS**

- A. Install complete set of floor plan drawings of valve locations, wall mounted, in mechanical rooms.

**3.11 EQUIPMENT NAMEPLATES**

- A. Install nameplates on or near each major item of mechanical equipment and each operational device. Install on accessible sides of equipment for the following general categories of equipment, operational devices, and for equipment scheduled on the Drawings:
  - 1. Pumps
  - 2. Domestic Water Booster Packages
  - 3. Fire Pumps
  - 4. Fans
  - 5. Packaged HVAC units
  - 6. Tank and pressure vessels
  - 7. Control panels
  - 8. Heat Recovery Units
  - 9. Dedicated Outdoor Air Units
  - 10. Domestic water heaters
  - 11. Fire dampers, smoke dampers, and combination fire/smoke dampers
- B. Install with self-tapping stainless steel screws or steel rivets, except use of contact-type permanent adhesive where screws cannot or should not penetrate substrate is acceptable.

3.12 EARTHWORK

- A. Perform earthwork required for installation of fire suppression, plumbing, and HVAC work below grade. Provide earthwork meeting requirements in this article, UPC, and Division 31, whichever is most stringent.
- B. Locate and protect existing utilities and other underground work in manner which will ensure that no damage or service interruption will result from excavating and backfilling. Perform excavation in a manner which protects walls, footings, and other structural members from being disturbed or damaged in any way.
- C. Coordinate excavations with weather conditions to minimize possibility of washouts, settlements and other damages and hazards.
- D. Do not excavate until required materials are on site and the work is ready to proceed without delay so that total time lapse from excavation to completion of backfilling will be minimal. Remove excavated material from jobsite. Reuse of excavated materials from trenches inside existing structures acceptable upon approval by the A/E.
- E. Excavate trenches of necessary width for proper laying of pipe with banks as nearly vertical as possible from trench bottom to 12 inch above top of pipe and conduit as detailed on the Drawings. Grade trench bottoms to provide uniform undisturbed bedding for each section of pipe. Form holes and depressions for joints after trench bottom has been graded. Provide temporary pumping equipment to keep excavation free from water. Install pipe bedding in rock excavation consisting of not less than 6 inch of sand or equivalent material. For non-metallic sewer and storm drain piping (for example, PVC, CPVC, PP, PE, PVDF, and ABS), comply with ASTM D 2321.
- F. Store native excavated material (temporarily) near excavation in manner which will not interfere with or damage excavation or other work.
- G. Provide bracing and shoring as necessary to maintain stability of excavation and to comply with safety codes.
- H. Provide imported material from off-site for use as the final backfill if excavated material is not approved by the A/E for reuse.
- I. Backfill trenches only after completion of pressure tests and inspection by the A/E. Install initial backfill material under, around, and between pipe and sides of trench by hand, shovel tamped in place. Cover in 6 inch layers to 12 inch thickness over top of pipe. For final backfill, fill and tamp remainder of backfill material in 6 inch layers. Provide backfill materials as follows:
  - 1. For metallic sewer and water piping, use pea gravel.
  - 2. For gas piping, use sand.
  - 3. For non-metallic piping (for example, PVC, CPVC, PP, PE, PVDF, and ABS), comply with ASTM D 2321.
- J. Wherever paving or future paving is indicated over backfill and areas where mechanical work is located outside building perimeter, such as for oil interceptors, oil tanks, and grease interceptors, where heavy equipment may impact piping, provide remainder of backfill with granular subgrade backfill material (Butler fill).

- K. Compacting:
  - 1. Perform compacting individually, for each 6 inch layer (maximum) loose thickness of initial and final backfill. Comply with ASTM D 1557. Where roadway or parking area surfaces will be placed over backfill and to 10 feet beyond building perimeter compacted to 95 percent of maximum density. Elsewhere, 90 percent. Test in accordance with Divisions 01 and 02.
  - 2. Take special care in compacting under services where they enter building to prevent settling. The Contractor fully responsible for damage to piping and property as result of settling around service piping.
- L. Dispose of surplus earth off-site in a suitable location.
- M. Place and maintain barricades, construction signs, torches, lanterns and guards as required during periods of open excavation to protect persons from injury and to avoid property damage.
- N. Leave premises thoroughly clean at completion of earthwork.
- O. Installation of Piping in Backfilled Areas: Wherever piping is to be installed in areas which have been excavated below pipe inverts, for any purpose, install piping to prevent subsequent settlement. Do not install piping until backfill is to full compaction, completed to minimum 18 inch above pipe to be installed. Install piping in re-excavated trenches and backfill as previously specified.
- P. Where subsidence is measurable or observable at mechanical work excavations during project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### 3.13 PAINTING

- A. Touch-up: Cover scratches, abrasions, and similar damages to equipment with factory finished surfaces using matching factory furnished paint.
- B. Grilles, Registers and Diffusers: Paint inside surface of ducts, visible through grilles, registers, diffusers, and other openings with 1 coat of flat black paint to a point 2 feet from opening on straight ducts or around bend. Similarly, paint pipes and conduits visible through ceiling relief grilles.

### 3.14 MISCELLANEOUS EQUIPMENT AND FIXTURE CONNECTIONS

- A. General: Install piping, ducts, and make final mechanical connections in accordance with manufacturer's recommendations for Owner-furnished equipment and fixtures, and equipment and fixtures specified in Divisions 01 through 14. This applies to work of, but not limited to, Sections 224000 and 233300.
- B. Coordination: Perform on-site review and refer to manufacturer's Shop Drawings for details of connections. Perform rough-in at locations to conveniently serve items.

3.15 **CLEANING AND HOUSEKEEPING**

- A. General: Comply with requirements in Division 01 and Section 233400 for air handling equipment.
- B. Remove debris, cuttings, crates, cartons, and similar items, created by Divisions 21, 22, and 23 Work at regular intervals. Perform at sufficient frequency to eliminate hazard to the public, other trades personnel, building, and the Owner's employees.
- C. Before Substantial Completion, carefully clean equipment, fixtures, exposed ducts and piping, and similar items. Remove construction labels, dirt, dust, cuttings, paint, plaster, mortar, concrete, and similar items.

3.16 **COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.17 **PIPE MARKERS AND COLOR BANDS SCHEDULE**

PIPE SYSTEM	COLOR
Domestic Cold Water	White Letters on Green
Domestic Hot Water	White Letters on Green
Domestic Hot Water Circulation	White Letters on Green
Non-Potable Cold Water	White Letters on Green
Tempered Water	White Letters on Green
Soil, Waste, and Vent	Black Letters on Yellow
Condensate Drain	Black Letters on Orange
Compressed Air	White Letters on Blue
Fire Suppression	White Letters on Red
Refrigerant Liquid	Black Letters on Yellow
Refrigerant Suction	Black Letters on Yellow

OUTSIDE PIPE DIAMETER (INCLUDING INSULATION) (INCH)	MINIMUM LENGTH OF LABEL COLOR FIELD (INCH)	MINIMUM LETTER HEIGHT (INCH)
3/4 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4

\*\*\*END OF SECTION\*\*\*

**SECTION 23 05 12  
INDOOR AIR QUALITY - HVAC**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes flush out (burn-in) utilizing outside air to be completed after Substantial Completion and prior to the Owner occupancy after significant finish materials have been installed. Refer to additional requirements in Section 230800.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Performance Data: Include the following in the written plan:
  - 1. Develop and submit written plan describing how 100 percent outside air flush out will be achieved after construction.
  - 2. Plan shall describe how 60 F to 65 F building temperature will be maintained and supporting calculations achieving minimum of 2 building volume air changes per hour.
  - 3. Plan shall also include how air quality will be maintained, including installation and periodic replacement of special filters and what measures will be taken to disable and protect return air openings during flush out periods.

**PART 2 - PRODUCTS**

Not used.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Prior to installation, inspect ducts for dust and confirm that oil film has been completely removed. Remove any dust, dirt, and remaining oil.
- B. Prior to system start-up, inspect ducts again for dust and other debris that may have collected during construction. Immediately remove any dust and debris using a HEPA vacuum.

- C. Prior to Substantial Completion and as condition precedent thereto, operate HVAC air distribution systems for 14 consecutive days on 100 percent outside air at ambient temperatures throughout building for 24 hours per day for minimum 7 consecutive days on 100 percent outside air. Do not commence flush out period until interior building construction components potentially emitting toxic pollutants are within building unless otherwise approved in writing by the Owner.
- D. Perform final flush out during non-occupied hours for minimum 7 days on 100 percent outside air after the Owner has moved all furniture in.
- E. Maintain building temperature during flush out period at not less than 60 F to 65 F unless otherwise approved in writing by the Owner. Minimum of 2 building volume air changes per hour is required during flush out period.
- F. Following final flush out, immediately replace filters, types as specified in Section 234100.

### 3.02 INSPECTION

- A. Prior to start of flush out period, notify the Owner and the A/E in writing that building is ready for inspection to verify completion. Allow 3 workdays after receipt of such notice for the Owner and the A/E to perform the inspection.
- B. Notice shall certify that finishes have been installed; ductwork, plenums and air handling equipment are clean, and free of dust, oil and other contaminants; air and water balancing have been completed; HVAC components have been tested; and start-up process has been completed.
- C. The Owner will issue written approval to start flush out period within 3 working days after receipt of notice or respond with remedial actions that need to be performed before approval can be issued.

### 3.03 SPECIAL CONSIDERATIONS FOR OCCUPIED AREAS

- A. When the building is partially occupied during construction, whether new or renovated facilities, operate the HVAC system to isolate occupied areas from where construction is occurring.
- B. Protect existing HVAC outside air intake and return air plenums from pollutant sources created by construction, including equipment exhaust and dust and odor pollution.

\*\*\*END OF SECTION\*\*\*



**SECTION 23 05 13**  
**ELECTRICAL PROVISIONS FOR MECHANICAL WORK**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes factory and field installed motors, motor starters, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. IEEE 112, IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
  - 2. NEMA MG 1, Motors and Generators.
  - 3. NFPA 70, National Electrical Code (NEC).
  - 4. UL 508A, Standard for Industrial Control Panels.
  - 5. UL 1995, Heating and Cooling Equipment.
- C. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NFPA 70 for workmanship and installation requirements and to applicable Division 26 sections.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Motor
  - 2. Motor starters

**PART 2 - PRODUCTS**

**2.01 MOTORS**

- A. Motor Characteristics: Except where more stringent requirements are indicated, and except where required item of mechanical equipment cannot be obtained to meet requirements in this article. Comply with the following requirements for motors for mechanical work:
  - 1. Comply with NEMA MG 1 unless otherwise indicated.

2. Temperature Rating: Rated for 40 C ambient temperature and at 3300 foot elevation with maximum 50 C temperature rise for continuous duty at full load (Class A insulation).
  3. Capacity and Torque: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment with indicated operating sequence, but without exceeding nameplate ratings or considering service factor.
  4. Phases and Current Characteristics: Squirrel-cage induction polyphase motors for 1/2 hp and larger. Permanent-split capacitor or capacitor-start single-phase motors for 1/3 hp and smaller, except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 sections and with individual equipment requirements specified in other Division 22 and 23 sections.
  5. Do not purchase motors that are either factory or field installed until power characteristics and rotation direction have been confirmed.
  6. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
  7. Motors 2 Hp and Larger: Include factory or field installed shaft grounding ring to prevent damage to motor bearings from induced shaft currents. Electro Static Technology-ITW AEGIS SGR™, Shaft Grounding Ring or approved.
- B. Motor Construction: General purpose, continuous duty motors, Design "B", except "C" where required for high starting torque.
1. Frames: NEMA standard.
  2. Bearings: Antifriction ball or sleeve bearings with inner and outer shaft seals, greaseable except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, bearings designed to resist thrust loading. Refer to other Division 22 and 23 sections for fractional-hp light-duty motors where sleeve-type bearings are permitted.
  3. Enclosure Type: Except as otherwise indicated open drip-proof motors for indoor use where satisfactorily housed, and guarded drip-proof motors where exposed to contact by employees and building occupants. Totally enclosed fan cooled for outdoor use. Refer to other Division 22 and 23 sections for other enclosure requirements.
  4. Overload Protection: Include for each motor. Built-in (manual reset) for 120, 208, and 277 V, single phase motors.
  5. Efficiency: Premium efficiency.
  6. Power Factor: Minimum 85 percent under full load conditions. Where less than 85 percent, include power factor correction to minimum 90 percent.
  7. Electronically Commutated Motors (ECMs): Variable speed DC brushless motor with single phase integrated controller/inverter. Motor designed for synchronous rotation to overcome reverse rotation. Rotor permanent magnetic type with near zero rotor losses. Motor with built-in soft start, soft speed change ramps, and permanently lubricated ball bearings. Include anti-back rotation feature or include motor designed to overcome reverse rotation without effect on motor life expectancy. Include device to limit electric harmonic distortion. General Electric ECM™ or approved.
  8. Nameplate: Include, indicating full identification of manufacturer, ratings, characteristics, construction, special features, and similar information as required by NEMA MG 1.

- C. Manufacturers: Except where item of mechanical equipment (which otherwise complies with requirements in this section) is integrally equipped with motor produced by another manufacturer, include motors by one of the following manufacturers: Baldor Electric Motor Company, General Electric Co., Marathon™ Electric Motors, Reliance Electric Motors, Toshiba International Corp., Siemens Corporation, Emerson Climate Technologies, US Electrical Motors, Gould Electric Motor, Louis Allis, Lincoln Motors, or Magnetek, Inc.

**2.02 MOTOR STARTERS**

- A. General: Comply with requirements in Division 26 for factory installed starters. Field installed starters are specified in Division 26 work.

**2.03 EQUIPMENT SHORT CIRCUIT CURRENT RATING**

- A. Mechanical equipment, packaged systems, control panels, motor starters, motor controllers, variable frequency drives and similar equipment shall carry a Short Circuit Current Rating (SCCR) equal to or greater than available fault current delivered from electrical system. Include visible factory nameplate for such equipment indicating SCCR of equipment in accordance with UL 1995 and UL 508A.

**PART 3 - EXECUTION**

**3.01 MOTORS**

- A. Where motors are furnished for field mounting, install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen screws on flat surfaces of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

**3.02 STARTERS**

- A. Coordinate with Division 26 work to install starters and wiring devices near motors or as indicated on the Drawings. Securely support and anchor in accordance with manufacturer's installation instructions. Locate for proper operational access, including visibility for safety.

**3.03 EQUIPMENT AND MOTOR CONNECTIONS**

- A. Install flexible-conduit connection to motor and equipment for packaged and non-packaged equipment that is factory assembled. Comply with applicable provisions of Division 26 sections for wiring materials and wiring services.
- B. Refer to Division 26 sections for installation requirements. Division 22 and 23 shall provide work not indicated in Division 26 for a complete and operating system. Where a conflict occurs between Division 22 and 23 and Division 26, Division 22 or 23 Contractor shall provide work for a complete and operating system. Refer to schedule included in this section for additional information.

**3.04 EQUIPMENT FABRICATION**

- A. Fabricate mechanical equipment for secure mounting of motors and other electrical items including in work. Include permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Install safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running maintenance without removal of guards.

**3.05 COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

**3.06 MECHANICAL – ELECTRICAL INTERFACE SCHEDULE**

- A. Establishing the separation of work between trades and subcontractors is not within scope of these Contract Documents. The following schedule is proposed for assistance in bidding only.
- B. Unless otherwise indicated in the Contract Documents, mechanical equipment and controls are suggested to be furnished, installed, and wired in accordance with the following schedule. Coordinate work with Division 26 sections.

ITEM	FURNISHED BY	INSTALLED BY	POWER WIRING BY	CONTROL WIRING BY
1. Equipment Motors:	M	M	E	M
2. Magnetic Motor Starters and Equipment Connections:				
a. Automatically Controlled with or without HOA Switches:	E	E	E	M
b. Manually Controlled:	E	E	E	E
c. Furnished with Mechanical Equipment, Factory Mounted:	M	M	E	M
d. Furnished with Mechanical Equipment, Field Mounted:	M	E	E	M
3. Disconnect Switches and 120 V Receptacles per IMC and NEC:	E	E	E	--
4. Manual Motor Starters, Thermal Overload Switches:	E	E	E	--
5. Combination Fire/Smoke Dampers, Smoke Dampers:	M	M	E	E
6. Section 230900 Automatic Temperature Controls: Valve and Damper Actuators, Low Voltage Electric Thermostats, Switches, other Miscellaneous Controls:	M	M	M	M
7. Electric Radiant Heating Panels, Baseboard Heaters, Cabinet Heaters, Unit Heaters:	M	M	E	M
8. Electric Duct Heating Coils:	M	M	E	M
9a. Duct Smoke Detectors:	E	M	E	E
9b. Relays and Ancillary Devices Associated with HVAC Unit Shutdown by Duct Smoke Detectors:	E	E	E	E
10. Section 230900 Control Panels:	M	M	E	M

M = Division 22 and 23, Mechanical  
E = Division 26, Electrical

\*\*\*END OF SECTION\*\*\*

**SECTION 23 05 48  
VIBRATION ISOLATION**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes products to isolate building structure and occupied spaces from vibration transmission for mechanical equipment and distribution systems. Isolation work shall include, but not necessarily be limited to, the following:
1. Supported isolation of motor-driven equipment.
  2. Isolation support of air-handling housings.
  3. Isolation support of piping, piping risers, and ductwork.
  4. Penetration isolation of pipes and ductwork through walls, floors, and ceilings.
  5. Flexible connections of ductwork and piping to equipment.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
1. Codes and Standards: ASTM C 94, Standard Specification for Ready-Mixed Concrete.
  2. ASTM G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
  3. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  4. NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
  5. NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data for the following:
1. Vibration isolation mounts.
  2. Vibration isolation hangers.
  3. Miscellaneous supports.
  4. Acoustical wrap.
  5. Flexible connectors.
  6. Miscellaneous products.
  7. Thrust restraints.

- C. Shop Drawings:
1. Bases and vibration isolation installation, including sizes, type, and placement of isolators. Include total operating weight of each isolated piece of equipment.
  2. Shop Drawings shall be stamped and signed by professional engineer licensed in engineering in state in which the Work is performed.
  3. Calculations: Sizing and weight distribution for vibration isolators and bases. Calculations shall be stamped and signed by professional structural engineer licensed in engineering in state in which the Work is performed.
- D. Isolator Schedule List: List size, type, load, and static deflection of each isolator. Number and color code to show its location. Mark code number and color on Shop Drawings, on each isolator, and on each base to ensure that the Contractor will place them in the proper locations.
- E. Procedures: Submit procedures and installation instructions for setting and adjusting vibration isolators and bases.
- F. Final Inspection Report: Vibration isolation manufacturer shall prepare and submit written report documenting final inspection and certifying that vibration isolators are properly installed and adjusted.

**1.04 CONTRACTOR RESPONSIBILITY FOR VIBRATION ISOLATION**

- A. General: A single supplier shall furnish isolation mounts, pads, sway braces, related hardware, and fabricate isolation bases for the Project unless otherwise specified.
- B. Responsibility: This supplier shall be responsible for selection and installation supervision of vibration isolators. Prepare engineering drawings and details and submit to the A/E. Perform installation supervision and provide adjustment instructions.

**1.05 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION**

- A. Section 233100 – Air Distribution: Flexible connectors.

**1.06 VIBRATION ISOLATION, GENERAL**

- A. Description:
1. Balanced set of vibration isolators for each item of equipment listed in Article “Vibration Isolation Schedule” in this section.
  2. Vibration isolation of piping and ducts as indicated in the Contract Documents and listed in Article “Vibration Isolation Schedule” in this section.
  3. Provide components or materials not specifically mentioned herein, but necessary for proper vibration isolation of equipment.
- B. Rotating Equipment Criteria: Maximum vibration levels at each bearing, while in operation not to exceed 0.08 inch/sec. If operating vibration velocities exceed this criteria, repair or replace equipment at no expense to the Owner until approval of equipment is given by the A/E.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Manufacturers: Mason Industries, Inc., Amber/Booth, Kinetics Noise Control, Vibration Mountings and Controls, Inc., Vibro-Acoustics®, Korfund Dynamics Corporation, California Dynamics Corp (CalDyn), TOLCO™, or approved. Mason Industries model numbers are listed.

2.02 VIBRATION ISOLATION MOUNTS

- A. Spring S-2, Housed Seismic Restraint Spring:
1. Description:
    - a. Designed to resiliently resist seismic forces in all directions.
    - b. Snubbing in all directions with adjustment to limit upward, downward, and horizontal travel to maximum of 1/4 inch before contacting snubbers.
    - c. Spring shall have seismic rating certified as an OSHPD Pre-approved Anchorage (OPA) from Office of Statewide Health Planning and Development (OSHPD) for State of California.
  2. Construction:
    - a. Leveling bolts rigidly bolted to the equipment with height-saving brackets and 1/4 inch neoprene waffle pad bonded to bottom of baseplate.
    - b. Spring diameter no less than 0.8 of compressed height of spring at rated load, with minimum additional travel to solid equal to 50 percent of rated deflection.
    - c. Maximum clearance of 1/4 inch maintained around restraining bolts and between housing and spring to prevent interference with spring action.
  3. Manufacturer and Model: Mason Industries SLR or SLRS Series.
- B. Neoprene N-1, Neoprene Mount:
1. Description: Captive neoprene mounting within steel housing for minimum static deflection of 0.2 inch in compression.
  2. Construction: Captive steel insert embedded in neoprene with load plate to permit bolting to supported equipment. Housing includes base plate with bolt holes.
  3. Manufacturer and Model: Mason Industries BR.

2.03 VIBRATION ISOLATION HANGERS

- A. Hanger H-2, Neoprene Hanger:
1. Description: Neoprene-in-shear or fiberglass isolator encased in welded steel bracket.
  2. Criteria: Minimum 0.35 inch operating static deflection.
  3. Manufacturer and Model: Mason Industries HD.



2.04 MISCELLANEOUS SUPPORTS

- A. Type IP-1, Isolation Pad:
1. Description: Neoprene waffle pads, with 2 layers of 3/4 inch thick neoprene separated by 16 gage galvanized sheet metal shim and load distribution plates. Size to limit surface pressure to 45 pounds per square inch. Where bolts are used to secure equipment, isolate bolts from equipment with neoprene washers and grommets. Allow no metal-to-metal contact between bolt and equipment.
  2. Manufacturer and Model: Mason Industries Super W.
- B. Type WB-1, Neoprene Washers and Bushings:
1. Washer-bushing manufactured of bridge bearing neoprene.
  2. Washer-bushing maximum loading not to exceed 1000 psi.
  3. Washer-bushing to be used such that direct contact between bolt and equipment is eliminated.
  4. Manufacturer and Model: Mason Industries HG.

2.05 ACOUSTICAL WRAP

- A. Description: Limp mass barrier material in sheet form for enclosing noise sources.
- B. Construction: PVC, 1 lb/sq. ft. weight, 400 lb/inch tensile strength, 140 lb/inch tear strength.
- C. Manufacturer and Model: Kinetics Noise Control KNM-100C or approved.

2.06 FLEXIBLE CONNECTORS

- A. General:
1. Comply with NFPA 90A and NFPA 90B.
  2. Fabric shall meet NFPA 701 and resist mildew per ASTM G 21.
- B. Ducts:
1. Indoor Applications:
    - a. Description: Flexible, woven fiberglass with neoprene coating, resistant to alkalis and gasoline and unaffected by mildew, 22 oz. per sq. yd, temperature range from minus 40 F to 200 F.
    - b. Manufacturers: Duro-Dyne Neoprene (Standard Grade), Ventfabrics, Inc., Ductmate Industries, Inc. PROflex™, or approved.
  2. Outdoor Applications:
    - a. Description: Woven polyester with vinyl coating, non-porous, double layered, R value of 4.2, temperature range from minus 40 F to 180 F.
    - b. Manufacturers: Duro Dyne Insulflex®, Ductmate Industries, Inc. PROflex™, or approved.

- C. Piping:
1. Braided Type for Pipe Sizes 2 Inch and Smaller:
    - a. Description: Corrugated stainless steel core covered with high tensile stainless steel woven wire braiding, minimum lateral deflection 1/2 inch.
    - b. Manufacturers: Keflex™ Manufacturing, Microflex, Inc., The Metraflex Company, Mercer Rubber Co., Garlock®, American Boa Inc.
  2. Elastomeric Type for Pipe Sizes 2-1/2 Inch and Larger:
    - a. Description: Multiple plies of Kevlar tire cord fabric and peroxide cured EDPM, both molded and cured in hydraulic rubber presses.
    - b. Construction: Two sphere cross-section, no steel wire or rings used as pressure reinforcement, floating steel flanges and solid steel rings within raised rubber flange ends to prevent pullout. Minimum rating 150 psi at 250 F. Connections made with flanged twin-spheres pre-extended as recommended by manufacturer to prevent additional elongation under pressure.
    - c. Control Assemblies: For sizes 8 inch and larger operating at pressures above 100 psi. Assembly with control cables with end fittings isolated from anchoring plates, and 1/2 inch thick neoprene washer bushings designed for maximum of 1,000 psi. Mason Industries ACC.
    - d. Manufacturers: Mason Industries Safeflex Series.
  3. Refer to Section 221123 for pump discharge flexible connectors.

## 2.07 MISCELLANEOUS PRODUCTS

- A. Fiberglass Acoustical Insulation:
1. General: One half inch thick, 3 pounds per cubic foot, density, unfaced fiberglass batts.
  2. Manufacturers: Owens Corning, Tremco, or approved.
- B. Acoustical Collar: Quarter inch thick closed cell foam.
- C. Resilient Sealant:
1. General: Paintable, non-hardening, non-bleeding, non-drying, resilient calk.
  2. Manufacturers and Models: USG Sheetrock® Brand Acoustical Sealant, Pecora Corporation Acoustical Sealant BA-98, Gloucester Corporation Phenoseal Surpass Flexible Sealant (clear color only), or approved.

## 2.08 THRUST RESTRAINTS

- A. Description: Spring in series with neoprene pad. Restraint assembly designed to be field adjusted to allow maximum 3/8 inch movement at equipment start and stop. Restraint assembly designed to sustain overload force equal to 5 times design force without failure. Include attachment hardware.
- B. Manufacturer and Model: Mason Industries WBI and WBD.

**2.09 FACTORY FINISHES**

- A. Apply manufacturer's standard paint to factory-assembled and tested equipment before shipping.
  - 1. Powder coating on springs and housings.
  - 2. Mechanically galvanized hardware. Hot dipped galvanize metal components where installed outdoors.
  - 3. Baked enamel for metal components where installed indoors.
  - 4. Color-code or otherwise mark vibration isolator devices to indicate capacity range.

**PART 3 - EXECUTION**

**3.01 INSPECTION**

- A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. Description: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Assistance: Vibration isolation supplier shall provide assistance to Contractor to ensure correct installation and adjustment of vibration isolators and seismic restraints.
- C. Prior to Startup: Clean foreign matter between base, isolator, equipment, and mounting surfaces. Verify that there are no rigid connections between equipment and building structure that degrade vibration isolation systems specified in this section.

**3.04 EQUIPMENT**

- A. Spring Mounts:
  - 1. Mark vibration isolators to show undeflected height to verify proper isolation after installation. Install isolators for single piece of equipment with approximately equal deflection. Mount equipment level.
  - 2. Coordinate with general contractor and structural engineer to ensure proper mounting attachment points.
  - 3. Install with Type WB-1 isolators.
- B. Spring Hanger Rods: Align isolator to clear isolator housing. Install housing as close as possible to structure.

**3.05 DUCTWORK**

- A. Penetrations of Mechanical Room Walls and Floors and Acoustical Walls and Ceilings:
1. Install sheet metal sleeves through walls and gypsum wallboard ceilings covering entire inside perimeter of oversized opening unless smoke dampers are indicated in the Contract Documents. Size penetration large enough to pack additional fiberglass and acoustical collar between duct or duct insulation and sheet metal sleeve. Trim excess foam and apply continuous bead of resilient sealant around penetration perimeter.

**3.06 PIPING**

- A. Equipment Supports: Coordinate piping supports with equipment supports to maintain uniformly efficient isolation, expansion and contraction, without creating excessive stresses at equipment connection or in portion of piping. Adjust vibration isolators after piping systems have been filled and equipment is at operating weight.
- B. Penetrations of Walls and Floors in General:
1. Install resilient sealant in annular space between sleeve and pipe as specified in this section.
  2. Comply with requirements in Section 230510 for sleeves through walls and floors.
  - 3.
- C. Penetrations of Mechanical Room Walls and Floors and Acoustical Walls and Ceilings:
1. Install sheet metal sleeves through walls and gypsum wallboard ceilings covering entire inside perimeter of inch oversized opening. Size penetration large enough to pack additional fiberglass acoustical insulation and acoustical collar between pipe and pipe insulation and sleeve. Trim excess foam and apply continuous bead of resilient sealant around penetration perimeter.
  2. Comply with requirements in Section 230510 for sleeves through floors, fire rated walls and floors, and sheet metal dams.
  3. Plaster sleeve to wall, ceiling, and floor to ensure airtight seal.

**3.07 THRUST RESTRAINTS**

- A. General: Install on plenum or plug fans with motors 3 horsepower and larger. Install between air handling unit floor casing panel and steel base for fan and motor.
- B. Fans: Install across flexible connection on fan discharge.

**3.08 ELECTRICAL CONNECTIONS TO VIBRATION ISOLATED EQUIPMENT**

- A. Comply with requirements in Section 230513.
- B. Do not install conduit clamps or hangers between flexible raceway termination and equipment connection.
- C. Recommended minimum flexible raceway length is 6 feet.

3.09 **COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.10 **VIBRATION ISOLATION SCHEDULE**

- A. Vibration isolator designations are keyed to items specified in this section.

EQUIPMENT	ISOLATOR	STATIC DEFLECTION (INCH)	BASE
<u>FANS</u>			
Air Handling Units with Plenum Plug or Scroll Centrifugal Fan, Floor-Mounted, Internally Isolated	Type S-2 by Mfr.	2.0	Internal by AHU Mfr.
Variable Air Volume Units, Suspended	Type H-2	0.35	
<u>PUMPS</u>			
Centrifugal, In-Line, Pipe-Mounted	Type N-1	0.2	
Variable Speed Pump Package	Type IP-1		By Pump Mfr.
<u>CONDENSING UNITS</u>	Type IP-1		By CU Mfr.
<u>ROOFTOP HVAC UNITS</u>	Internal: Type S-2	2.0	By Unit Mfr.
<u>COMPRESSORS</u>	Type S-2	2.0	By Comp Mfr.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 05 50  
SEISMIC CONTROL**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes seismic restraints for mechanical equipment and distribution systems
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASCE 7, Minimum Design Loads For Buildings and other Structures.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data for the following:
  - 1. Seismic restraints
  - 2. Miscellaneous supports
- C. Shop Drawings:
  - 1. Seismic restraint installations, including calculations.
  - 2. Shop Drawings shall be stamped and signed by a professional engineer licensed in engineering in the state in which the Work is performed.
- D. Calculations: Sizing and weight distribution for seismic restraints. Calculations shall be stamped and signed by a professional engineer licensed in engineering in the state in which the Work is performed.
- E. Seismically Certified Equipment: Submit testing installation details.
- F. Seismic Restraint Details: Detail fabrication and attachment of seismic restraints. Include the following:
  - 1. Anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
  - 2. Overturning force calculations and other design calculations.
  - 3. Seismic brace layouts indicating locations of seismic bracing.
  - 4. Details for seismic restraints and attachment to structure.

- 5. Additional design information as required by IBC and ASCE 7.
- G. Procedures: Submit procedures and installation instructions for setting and adjusting seismic restraints.
- H. Final Inspection Report: Seismic restraint manufacturer shall prepare and submit written report documenting final inspection and certifying that seismic restraints are properly installed and adjusted.

**1.04 CONTRACTOR RESPONSIBILITY FOR SEISMIC RESTRAINTS**

- A. General: A single supplier shall furnish seismic restraints, sway braces, and related hardware for the project unless otherwise specified.
- B. Responsibility: This supplier shall be responsible for selection and installation supervision of seismic restraints. Prepare engineering drawings and details and submit to the A/E. Perform installation supervision and provide adjustment instructions.
- C. Seismic Restraints:
  - 1. Design and select restraint devices for ducts, pipes, and equipment to meet seismic requirements defined in IBC and ASCE 7. Prepare calculations based on coefficients included on the structural drawings. Refer to the structural drawings for allowable methods and loads.

**1.05 SEISMIC RESTRAINTS, GENERAL**

- A. Description:
  - 1. Seismic restraint of equipment as indicated in the Contract Documents and as listed in Article "Seismic Restraint Schedule" in this section.
  - 2. Seismic restraint of piping and ducts as indicated in the Contract Documents and listed in Article "Seismic Restraint Schedule" in this section.
  - 3. Provide components or materials not specifically mentioned herein, but necessary for proper seismic control of equipment.

**PART 2 - PRODUCTS**

**2.01 GENERAL**

- A. Manufacturers: Mason Industries, Inc., Amber/Booth, Kinetics Noise Control, Vibration Mountings and Controls, Vibro-Acoustics®, Korfund Dynamics Corporation, California Dynamics Corp (CalDyn), TOLCO™, or approved. Mason Industries model numbers are listed.

**2.02 MISCELLANEOUS SUPPORTS**

- A. Type WB-1, Neoprene Washers and Bushings:
  - 1. Washer-bushing manufactured of bridge bearing neoprene.
  - 2. Washer-bushing maximum loading not to exceed 1000 psi.
  - 3. Washer-bushing to be used such that direct contact between bolt and equipment is eliminated.
  - 4. Manufacturer and Model: Mason Industries HG.

## 2.03 SEISMIC RESTRAINTS

### A. General:

1. Restraints capable of safely accepting external forces as defined in IBC and applicable state and local codes without failure to maintain mechanical equipment, piping, and duct in captive position.
2. Seismic devices not to interfere with vibration isolators during normal operation.
3. Seismic mounts shall have State of California OPA number verifying maximum certified horizontal and vertical load ratings.

### B. Seismic Restraint E-1:

1. Description: Interlocking steel members restrained by shock absorbent rubber materials compounded to bridge-bearing specifications.
2. Construction:
  - a. Elastomeric materials replaceable, minimum 1/4 inch thick molded bushing.
  - b. Air gap between hard and resilient material of not less than 1/8 inch, nor more than 1/4 inch.
3. Application: Locate and size snubbers to suit application. Furnish sufficient quantity such that restraint load rating will not be exceeded. Minimum of 4 snubbers required.
4. Manufacturer and Model: Mason Industries Z-1225.

### C. Seismic Restraint E-2:

1. Description: Pre-stretched galvanized steel cable assembly with swivel end connections using 2 clamping bolts. Vertical rods at seismic brace locations braced with and rod clamp assembly to accept compressive loads.
2. Application: Cables sized to accommodate loads with minimum safety factor of 2.
3. Manufacturer and Model: Mason Industries SCB with SSB rod clamp assembly.

## 2.04 FACTORY FINISHES

### A. Apply manufacturer's standard paint to factory-assembled and tested equipment before shipping.

1. Mechanically galvanized hardware. Hot dipped galvanize metal components where installed outdoors.
2. Baked enamel for metal components where installed indoors.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- ### A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.



**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. Description: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Assistance: Seismic restraint supplier shall provide assistance to Contractor to ensure correct installation and adjustment of seismic restraints.

**3.04 EQUIPMENT, PIPING, AND DUCT SEISMIC RESTRAINTS**

- A. General: Comply with requirements in IBC and ASCE 7 unless otherwise indicated in the Contract Documents.
- B. Coordination: Coordinate with submittals and Shop Drawings of mechanical equipment such as pumps, air handling units, fans, and similar items. Coordinate with general contractor and structural engineer to ensure correct mounting attachment points.
- C. Vibration-Isolated Equipment, Piping, and Ducts:
  - 1. Install seismic restraints with factory set clearances. Install seismic restraint to avoid short circuiting of vibration isolators.
  - 2. Isolate bolts from direct contact with structure with Type WB-1 isolators.

**3.05 COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

**3.06 SEISMIC RESTRAINT SCHEDULE**

- A. Seismic restraint designations are keyed to items specified in this section.

EQUIPMENT	SEISMIC RESTRAINT
<b>FANS</b>	
Air Handling Units with Plenum Plug or Scroll Centrifugal Fan, Floor-Mounted, Internally Isolated	Internal: Housed Seismic Restraint Spring Type S-2 per Section 230548 External: Type E-1
Variable Air Volume Units, Suspended	Type E-2
<b>PUMPS</b>	
Centrifugal, In-Line, Pipe-Mounted	Type E-2

EQUIPMENT	SEISMIC RESTRAINT
Variable Speed Pump Package	Type E-1
<u>CONDENSING UNITS</u>	Type E-1
<u>ROOFTOP HVAC UNITS</u>	Internal Housed Seismic Restraint Spring Type S-2 per Section 230548 External: Type E-1
<u>COMPRESSORS</u>	Housed Seismic Restraint Spring Type S-2 per Section 230548
<u>PIPING</u>	IBC
<u>DUCTS</u>	IBC

\*\*\*END OF SECTION\*\*\*

**SECTION 23 05 93  
TESTING, ADJUSTING, AND BALANCING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes testing, adjusting, and balancing (TAB) of mechanical systems.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. AABC, National Standards for Total Systems Balance.
  - 2. ASHRAE 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
  - 3. NEEB, Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
  - 4. UL 873, Standard for Temperature - Indicating and Temperature-Regulating Equipment.
- C. TAB Subcontractor:
  - 1. General: TAB work performed by independent subcontractor, not affiliated with the Contractor.
  - 2. Qualifications: Certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).
  - 3. Experience: Minimum 5 years on projects of similar scope and complexity.
  - 4. TAB Subcontractors: Air Balance Associates, National Indoor Air Care Corporation, AIRTEST Co. Inc., United Test & Balance Inc., or Neudorfer Engineers, Inc. No substitutions.
  - 5. Obtain associated Product Data and Shop Drawings required to determine design-to-actual operating data (coil pressure drops, fan curves and similar data).

**1.03 SUBMITTALS**

- A. General: Comply with requirements in Division 01 and Section 230500.
- B. Preliminary Data: Submit the following within 30 days after award of contract:
  - 1. Name of TAB subcontractor.
  - 2. Individual qualifications of persons responsible for supervising and performing the work of this project.

3. TAB agenda listing methods and procedures, and including blank forms applicable to this project. Include blank system readiness checklists for air systems, hydronic systems, and controls. Include sample field reports and corrective action log.
  4. List of projects completed by TAB subcontractor of similar size, scope and equipment. Include name of the Contractor and the Owner contacts.
  5. List of test instruments.
  6. System flow diagrams with pertinent data (flow, pressure, velocity design) for each system to be balanced.
  7. Proposed final report table of contents.
  8. Sample executive summary that will be included in final report.
- C. Pre-Balance System Check-Out Report: Prior to commencement of TAB work, Contractor shall confirm in writing to TAB subcontractor, with copies of notice to the A/E and the Owner, that equipment and system check-out has been performed as described in Article "Work by Contractor".
- D. Balancing Report:
1. Provide complete balancing report in accordance with NEBB or AABC requirements, including the following:
    - a. System flow diagrams and floor plans.
    - b. Pump curves.
    - c. Fan curves.
    - d. Manufacturers' start-up and test data.
    - e. Field start-up and test reports prepared by system and equipment installers.
    - f. List of test instruments and dates of last calibrated.
    - g. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
  2. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
    - a. Title page.
    - b. Name and address of testing, adjusting, and balancing Agent.
    - c. Project name.
    - d. Project location.
    - e. Architect's name and address.
    - f. Engineer's name and address.
    - g. Contractor's name and address.
    - h. Report date.
    - i. Signature of testing, adjusting, and balancing supervisor who certifies report.
    - j. Summary of contents, including the following:
      - 1) Design versus final performance.
      - 2) Notable characteristics of systems.
      - 3) Description of system operation sequence if it varies from the Contract Documents.
    - k. Nomenclature sheets for each item of equipment.
    - l. Data for terminal units, including manufacturer, type size, and fittings.

- m. Test conditions for fans and pump performance forms, including the following:
  - 1) Settings for outdoor, return, and exhaust air dampers.
  - 2) Conditions of filters.
  - 3) Cooling coil, wet- and dry-bulb conditions.
  - 4) Fan drive settings, including settings and percentage of maximum pitch diameter.
  - 5) Settings for supply air static pressure controller.
  - 6) Other system operating conditions that affect performance.

#### 1.04 JOB CONDITIONS

- A. Make 3 site visits to assess system readiness prior to start of TAB work.
- B. Do not proceed with TAB work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- C. Partial Owner Occupancy: The Owner may occupy completed areas of building before Substantial Completion. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.

#### 1.05 COORDINATION

- A. Attend and participate in 3 field coordination meetings, contributing air and water balancing requirements to field coordination documents. Arrange with the Contractor to have representatives of mechanical, electrical, sheet metal, and control subcontractors be present at each meeting.
- B. Coordinate efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- C. Give 7 days' advance notice to parties needing to be present or to participate with tests and to the A/E for each test. Include scheduled test dates and times.
- D. Perform TAB work after leakage and pressure tests on air and water distribution systems have been satisfactorily completed. Refer to Section 233100 for allowable duct leakage requirements.

#### 1.06 SEQUENCING/SCHEDULING

- A. General: Phase in properly with the A/E reviewed/accepted Construction Schedule with respect to flooring work (carpet laying and tiling), ceiling installation, final building cleaning, fire alarm system testing, and similar activities that would affect TAB work.

PART 2 - PRODUCTS

2.01 INSTRUMENTS

- A. General: Furnish materials and equipment necessary to measure system capacities, electrical voltage and current, fan speeds, static pressures, air velocities, water pressure drops, and other readings necessary to evaluate system performance and adjust quantities to those indicated. Materials and equipment shall remain in possession of TAB subcontractor after project is completed.
- B. Instrumentation: Use in accordance with manufacturer's instructions.
- C. Calibration: At least every 12 months.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.03 PERFORMANCE

- A. Description: Perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, more stringent requirements govern.

3.04 SYSTEM READINESS PRIOR TO TAB WORK

- A. System Performance: The Contractor is responsible for performance of equipment and systems. Do not assume that supplier will ship equipment adjusted to meet project requirements.
- B. Equipment Operation:
  - 1. Check equipment for proper operation as soon as electrical power is available. Perform adjustments required for proper operation.
  - 2. Report malfunctions to manufacturer and take corrective action immediately to prevent delay of work.
  - 3. Check-out equipment for electrical problems, check rotation of motors, read voltage and current in each leg of each motor, heater, and similar devices, and check readings against nameplate. Lubricate per manufacturer's recommendations.
  - 4. Before testing, adjusting, and balancing commences, operate (test run) equipment for minimum 1 week.

5. Complete pre-functional equipment and systems checklists prepared by the Commissioning Authority and submit signed and dated copies to the Owner, the A/E, and TAB subcontractor.
- C. Air Distribution System Inspection: Check out air distribution system to ensure that fans are connected to ducts, that outlets are connected to branch ducts, and that a volume damper exists for each air device (supply, return, and exhaust) and is in the wide-open position. Verify installation and function of branch volume dampers.
- D. Controls Operation: Check out and calibrate control components under equipment and system operation service. These components include, but are not limited to, thermostats and temperature sensors to ensure they are connected to appropriate devices, respond to temperature changes, and perform correct action compatible with controlled devices.
- E. Filters: After equipment and system check-out work has been completed, and prior to commencement of TAB work, perform the following:
  1. Remove air filters in air distribution equipment and systems and install new filters as specified in Section 234100.
- F. Access: Provide scaffolds, staging, and accessories required to allow TAB subcontractor to gain access to equipment, dampers, valves, and other devices located beyond range of 6 foot stepladder.
- G. Pump Impeller Trim: For constant volume systems that use pump discharge valves to reduce pump head by more than 10 percent of design to achieve balanced conditions, remove impeller and based on TAB subcontractor requirements for proper impeller diameter, arrange for impeller trim and statically and dynamically balance after trim by the pump manufacturer or authorized representative, reinstall, and replace nameplate tag that reflects the as-built condition.
- H. Instrument Test Holes: Install at locations as directed by TAB subcontractor. Refer to Section 233100.
- I. Cleaning: Clean equipment and devices after check-out and test run period prior to TAB work.

### 3.05 WORK BY TAB SUBCONTRACTOR

- A. General: Adjust quantities to within percent of design values as follows:
  1. Supply air outlets and fans 0 to plus 10 percent
  2. Return and exhaust fans 0 to plus 10 percent
  3. Return and exhaust air inlets 0 to minus 10 percent
  4. Heating and cooling flows 0 to minus 10 percent
- B. Systems: Include, but are not limited to, the following:
  1. Supply air systems.
  2. Return air systems.
  3. Exhaust air systems.
  4. Ventilation systems.
  5. Auxiliary heating and cooling systems.
  6. Domestic hot water circulating systems.

- C. Readings:
1. General: Take readings including, but not limited to, the following:
    - a. Air Quantities:
      - 1) Supply, return, exhaust, and outdoor air at each terminal.
      - 2) Perform duct transverse at branch mains conveying minimum 2000 cfm and for system total air.
    - b. Air Temperatures:
      - 1) Outdoor air at equipment.
      - 2) Return air at equipment.
      - 3) Supply air leaving equipment.
      - 4) Mixture of outdoor and return air before entering cooling and heating coils and other heat transfer equipment.
    - c. Air Handling Equipment:
      - 1) Fan RPM
      - 2) System static pressure and fan suction and discharge pressures.
      - 3) Clean filter pressure drop.
      - 4) Heating and cooling coil air pressure drop.
      - 5) Sheave make, sizes, and shaft size.
      - 6) Number of belts, make, and size.
    - d. Electrical:
      - 1) Measured voltage and amps on each phase of each motor (for example, pumps and fans) while equipment is under maximum normal load.
      - 2) The nameplate voltage and current for each motor.
  2. Compare pressure drop readings to manufacturers' rating sheets to determine actual flow through equipment.
  3. Explain readings out of range.
- D. System Difficulties: Obtain readings on each unit or piece of equipment as early as possible such that discrepancies can be resolved before anticipated close of job.
- E. Filter Pressure Drop: Following proportional adjustment of supply air outlets, measure initial clean filter pressure drop. Simulate filter loading by covering face of filters to increase filter pressure drop. For constant volume systems, use average of clean and final pressure drops. For VAV systems, use final pressure drop. If final pressure drop is not indicated on the Drawings, contact the A/E. Adjust fan drive to produce design value within allowable range for supply air fans. Remeasure clean filter pressure drop at final fan setting.
- F. Static Pressure Setpoint for Variable Air Volume (VAV) Air Handling Systems:



1. Adjust fan speeds and system static pressure setpoint, as necessary, to attain full cooling airflow rate throughout system with variable frequency drive operating near lowest frequency. Simulate dirty filter pressure drop and record readings. Ensure full load amperages at fan motors are not exceeded. Cooling coil surface shall be wet during full-cooling balancing. Record system operating static pressure setpoint.
  2. Set system static pressure setpoint to lowest pressure that will maintain sufficient inlet pressure at hydraulically most distant VAV unit. Record number of "hydraulically most distant unit". Confirm sufficient static pressure at most distant unit by reading airflow delivered from that unit. Record duct static pressure at the "hydraulically most distant unit" that corresponds with supply air fan duct static pressure setpoint in both minimum and 100 percent outdoor air modes.
- G. Fan Adjustment:
1. Verify that fans with electronically commutated motors (ECMs) have been adjusted at the equipment factory as required by Section 233300. Make further adjustments to achieve design air flow.
- H. Outdoor Air/Economizer Cycles:
1. After supply air outlets and return air inlets are in balance and air quantities correct, adjust outdoor air damper to minimum air quantity indicated on the Drawings for each system. If not indicated, contact A/E for minimum outdoor air quantities.
  2. Adjust using temperature averaging method when outside air temperature is 15 F higher or lower than return air temperature.
  3. If economizer control is specified, check for setting of controls and for operation of dampers (outdoor air, return air, and relief). Adjust return/relief system to result in a slight positive pressure in building (0.03 to 0.05 inch w.g.) with exhaust fans in operation. Indicate which mode air handling system was in when outlets were balanced (minimum and 100 percent outdoor air modes).
  4. Prepare outdoor air summary sheet indicating minimum outdoor air quantity for each system as designed and as tested. Include percent of minimum outdoor air.
- I. Inspection and Recheck:
1. Upon request, recheck random selections of up to 10 percent of readings recorded in Balancing Report in presence of the Owner's representative.
  2. Balancing Report will be rejected if more than 20 percent of rechecked readings deviate more than 10 percent of recorded readings in report. In this event, perform complete rebalancing of system.
  3. Life safety, stairwell pressurization and elevator pressurization systems [and systems serving rooms that need to maintain required pressure relationships] will be rechecked in their entirety.
- J. Marking of Adjustments:
1. After final inspection and recheck, permanently mark dampers, valves, and other adjustment devices to allow adjustment to be restored if disturbed in the future.
  2. If recheck requires re-balancing, eradicate previous markings and re-mark.
  3. Set and lock valve memory stops.
- K. Final Field Activities: Prior to final acceptance, perform the following:
1. Leave systems in proper working operation.

2. Close access doors.
3. Reinstall covers on electrical J-boxes and switch boxes.
4. Restore thermostat settings to original settings.
5. Reinstall insulation over balancing valves and pumps.
6. Patch holes in insulation, ductwork and equipment housing, which have been cut or drilled for TAB work in manner recommended by insulation subcontractor.
7. Adjust vanes on adjustable grilles and diffusers and modular type diffusers to eliminate drafts and to prevent stratification for air circulation acceptable to the A/E.
8. Reinstall ceiling tiles.

**3.06 ADDITIONAL TESTS**

- A. Within 90 days of completing TAB work, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

**3.07 COMMISSIONING**

- A. Equipment and systems referenced in this Section shall be commissioned per Section 230800. The Contractor and TAB subcontractor have specific responsibilities for scheduling, coordination, test development, testing and documentation.
- B. Submit preliminary report of balance data to the Commissioning Authority and the A/E. This documentation shall be requirement for final functional performance testing.
- C. Participate in selected (maximum of 6) commissioning meetings for coordination and support of commissioning process.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 07 00  
MECHANICAL INSULATION**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes insulation for plumbing and HVAC piping, ductwork, and equipment.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Applicable energy code.
  - 2. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - 3. ASTM C 533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  - 4. ASTM C 534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
  - 5. ASTM C 547, Standard Specification for Mineral Fiber Pipe Insulation.
  - 6. ASTM C 552, Standard Specification for Cellular Glass Thermal Insulation.
  - 7. ASTM C 553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - 8. ASTM C 1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
  - 9. ASTM C 1139, Standard Specification for Fibrous Glass Thermal Insulation and Sound Absorbing Blanket and Board for Military Applications.
  - 10. ASTM C 1290, Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
  - 11. ASTM C 1729, Standard Specification for Aluminum Jacketing for Insulation.
  - 12. ASTM C 1767, Standard Specification for Stainless Steel Jacketing for Insulation.
  - 13. ASTM D 1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Components.
  - 14. ASTM D 5590, Standard Test Methods for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay.
  - 15. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 16. ASTM E 96, Standard Test Methods for Water Vapor Transmission of Materials.
  - 17. ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
  - 18. ASTM F 1249, Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
  - 19. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - 20. National Commercial & Industrial Insulation Standards (NCIIS)

21. UL 723, Tests for Surface Burning Characteristics of Building Materials.
- C. Insulation Subcontractor's Qualifications: Specialty contractor normally engaged using products from manufacturers specified in this section.
- D. GREENGUARD Environmental Institute™ Certification: Include for pipe insulation and duct wrap and rigid board duct insulation.

#### 1.03 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data, installation data, and certifications for the following:
  1. Piping system insulation
  2. Duct system insulation
  3. Equipment insulation
  4. Inserts
  5. Insulation shields
  6. Jacketing

#### 1.04 DEFINITIONS AND ABBREVIATIONS

- A. Definitions:
  1. "Exposed" and "Concealed" are defined in Section 230500.
  2. "Cold Plumbing Piping" includes the following down to 0 F:
    - a. Domestic cold water.
    - b. Non-potable cold water.
    - c. Indirect condensate drain.
  3. "Cold HVAC Piping" includes the following:
    - a. Chilled water supply and return.
    - b. Refrigerant suction.
    - c. Refrigerant liquid.
  4. "Hot Plumbing Piping" includes the following:
    - a. Hot water and hot water circulating.
  5. "Hot HVAC Piping" includes the following up to 850 F:
    - a. Refrigerant discharge (hot gas).
  6. "Conditioned Air Duct" is duct for air that is heated, cooled, or humidified, and includes supply, return, and outdoor air intake and combustion air ducts.
  7. "Duct Not Within Conditioned Space" is duct for air that is located outside the building envelope or in unconditioned space.

8. "Duct Within Conditioned Space" is duct for air that is located inside the building envelope including outdoor air duct and relief duct on the building side of motor operated and backdraft dampers.
9. "Duct Within Conditioned Space Functioning as part of Building Envelope" is duct for air that is located in the building but on the outdoor side of motor operated and backdraft dampers.
10. "Equipment" includes the following:
  - a. Cold Equipment:
    - 1) Air separators.
    - 2) Pipe unions.
    - 3) Strainers.
    - 4) Domestic water booster package.
  - b. Hot Equipment:
    - 1) Domestic water heaters.
    - 2) Expansion tanks.
    - 3) Air separators.
    - 4) Pipe unions.
    - 5) Strainers.
11. "Piping" includes pipe, fittings, valves, and appurtenances.

B. Abbreviations:

1. ASJ: All-service jacket.
2. FSK: Foil-scrim-kraft jacket.
3. PCF: Pound per cubic foot density.
4. Perm: Water vapor transmission rate (permeability).
5. SSL: Self-sealing lap.

1.05 **SURFACE BURNING CHARACTERISTICS**

- A. Provide composite or component ratings per ASTM E 84 and UL 723 with flame spread rating not greater than 25 and smoke developed rating not greater than 50.
- B. Composite includes insulation, jacketing, and adhesive used to secure jacketing or facing.
- C. Components include PVC jacketing and fittings, adhesive, coating, mastic, cement, tape, and cloth.

PART 2 - PRODUCTS

2.01 **MATERIALS**

- A. Fiberglass Pipe Insulation: ASTM C 547, Type 1. Include factory applied ASJ/SSL. K-value not greater than 0.23 at 75 F mean temperature.
- B. Fiberglass Pipe Fitting Insulation: Thermal blanket, ASTM C 553, Type I or II. K-value not greater than 0.26 at 75 F mean temperature.

- C. EDPM Elastomeric Pipe Insulation: ASTM C 534, Type I for tubular materials, Grade 1. K-value not greater than 0.27 at 75 F mean temperature. Water vapor transmission not greater than 0.05.
- D. Fiberglass Duct Insulation: ASTM C 553, Type I, II, or III, ASTM C 1290, ASTM C 1139, Type III (faced), ASTM E 84, and ASTM C 1136, Type II for FSK jacket. 0.75 PCF for duct wrap and 3 PCF for concealed and 6 PCF for exposed rigid board.
- E. EDPM Elastomeric Duct Insulation: ASTM C 534, Type II for sheet materials, Grade 1. K-value not greater than 0.245 at 75 F mean temperature. Water vapor transmission not greater than 0.03.
- F. Staples, Bands, and Wires: As recommended by insulation manufacturer for applications indicated.
- G. Adhesives, Sealants, Coatings, Mastics, and Protective Finishes:
  - 1. Joint Sealants for Below-Ambient Cellular Glass Insulation: Childers CP-70 Chil-Joint® and CP-76 Chil-Byl®, Foster® 30-45™ N Foamseal® and 95-50™ Flextra®, Pittsburgh Corning Corporation Pittseal® 444N or approved.
  - 2. FSK and Metal Jacket Flashing Sealants: Childers CP-76 Chil-Byl®, Foster® 95-44™ Elastolar®, Pittsburgh Corning Corporation Pittseal® 444N or approved.
  - 3. Vapor Barrier Coatings: Water based suitable for indoor use on below-ambient services. Childers CP-34, or Vimasco Corporation 749 or approved. Water vapor permeance per ASTM F 1249, 0.08 perms or less at 45 mil dry. White color. Foster® 30-65™ Vapor-Fas™ WB or approved.
  - 4. Weather Barrier Breather Mastic: Water based suitable for indoor and outdoor use on above-ambient services. Water vapor permeance: ASTM F 1249, 1.8 perms at 0.0625 inch dry film thickness. White color. Childers CP-10 Ak-Cryl™ and CP-11 Ak-Cryl™, Foster® 46-50™ Weatherite, Vimasco WC-1 and WC-5, or approved.
  - 5. Elastomeric Insulation Coating: Water based polyacrylate copolymer emulsion finish. Armaflex WB, K-Flex® 374, Aeroflex USA, Inc, Aerocoat™, or approved.
  - 6. Elastomeric Insulation Adhesive: Foster® 85-75™ Drion®, Armacell® 520, Aeroflex USA, Inc. AeroSeal,™ or approved.
  - 7. Lagging Adhesive: For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Childers CP-50A HV2 Chil-Seal, Foster® 30-36™ Sealfas®, Vimasco Corporation 713 and 714 or approved.

## 2.02 MANUFACTURERS

- A. Fiberglass Pipe and Duct Insulation: CertainTeed, Knauf Insulation Earthwool®, 1000°, Manson Insulation ALLEY-K™, Johns Manville, Owens-Corning, or approved.
- B. EPDM Elastomeric Pipe and Duct Insulation: Aeroflex USA Inc., Aerocel-SSPT (Stay-Seal® with Protape® and Cel-Link II®), K-Flex® USA, Armacell®, or approved.
- C. Adhesives, Sealants, Coatings, Mastics, and Protective Finishes: Foster, Childers, Pittsburgh Corning, Vimasco, Armacell®, K-Flex®, Aeroflex USA, Inc., or approved.

### 2.03 PIPING SYSTEM INSULATION

- A. Insulation materials and thicknesses shall meet or exceed insulation requirements of applicable energy code. Where insulation thickness indicated on the Drawings or specified in this section is thicker than that listed in applicable energy code, use thicker values. Refer to Article "Extent of Piping Insulation" in this section.
- B. Insulate cold plumbing and cold HVAC piping with fiberglass or elastomeric insulation.
- C. Insulate cold plumbing and cold HVAC piping at wall supports with elastomeric, same thickness as adjacent fiberglass or elastomeric pipe insulation. Aerofix-U™ Insulating Pipe Hanger Support or approved. At Contractor's option, insulated pipe hangers specified in Section 232116 acceptable.
- D. Include factory applied ASJ/SSL on fiberglass or elastomeric pipe insulation. For below ambient piping, seal seams with vapor barrier coating.
- E. Fittings, Flanges:
  - 1. General: Thickness equal to adjacent pipe insulation.
  - 2. Indoor: Preformed fiberglass or elastomeric insulation, mitered sections of pipe insulation, or fiberglass or elastomeric insulation blanket. For below ambient piping, coat insulated elbows and fittings with vapor barrier coating and reinforcing mesh. Finish with one-piece premolded PVC fitting covers.
  - 3. Outdoor Jacketing: Preformed fiberglass or elastomeric insulation, mitered sections of pipe insulation, or contoured fiberglass or elastomeric insulation inserts. On below ambient piping, coat insulated elbows and fittings with vapor barrier coating and reinforcing mesh. Finish with preformed outdoor grade ultraviolet-resistant PVC jacket identical in composition to adjacent jacketing.
- F. Valves, Specialties, and Pumps:
  - 1. Removable pad type flexible blanket sandwich section of fiberglass, equal thickness as adjacent insulation, enclosed in silicone impregnated glass cloth cover machine sewed at ends.
  - 2. Include stainless steel "D" ring straps with Velcro tabs or full length Velcro at longitudinal seam.
  - 3. Length of blanket sufficient for removal of bolts without damaging adjacent insulation.
  - 4. Manufacturer: Shannon Enterprises INSULTECH® or approved.
- G. Adhesives, Mastics, and Cements: Compatible with piping insulation.

### 2.04 DUCT SYSTEM INSULATION

- A. Insulation materials and thicknesses shall meet or exceed insulation requirements of the applicable energy code. Where insulation thickness specified is larger than those listed in the applicable energy code, use the larger values. Refer to Article "Extent of Duct Insulation" in this section.
- B. Duct Wrap: Flexible fiberglass duct wrap or elastomeric insulation with factory applied FSK facing (vapor barrier) consisting of aluminum foil reinforced with fiberglass scrim laminated meeting ASTM E 84 and UL 723. Finish duct insulation seams with tape and vapor barrier coating.

- C. Rigid Board: ASJ, R-value not less than 4.2.
- D. Adhesives, Mastics, Coatings, Sealants, and Cements: As specified in Article "Materials" in this section. Compatible with duct and plenum insulation.

#### 2.05 EQUIPMENT INSULATION

- A. Insulate equipment with fiberglass, 2 inch thick. Fiberglass board, maximum 0.02 perm vapor transmission rate. K-value not greater than 0.23 at 75 F mean temperature.
  - 1. Exposed:
    - a. 6 PCF, ASJ or FSK facing.
    - b. 6 PCF, ASJ, glass cloth and mastic finish with corner beads.
  - 2. Concealed and Exposed Irregular Surfaces:
    - a. 3 PCF, ASJ or FSK facing.
    - b. 3 PCF, ASJ, glass cloth and mastic finish with corner beads.

#### 2.06 INSERTS BETWEEN PIPES AND PIPE HANGERS

- A. Material: Hydrous calcium silicate insulation or other heavy density insulating material for hot plumbing and hot HVAC piping, minimum 12 inch long inserts, thickness equal to adjoining insulation. Insulating material suitable for required temperature range. For cold plumbing and cold HVAC piping, use Aerofix-U™ Insulating Pipe Hanger Support or approved. At Contractor's option, insulated pipe hangers specified in Section 232116 acceptable.

#### 2.07 INSULATION SHIELDS

- A. Material: Minimum 12 inch long, galvanized steel, 18 gage for pipe sizes 4 inch and smaller and 14 gage for pipe sizes 6 inch and larger. Anvil International, Fee & Mason, Elcen, or approved.

#### 2.08 JACKETING

- A. PVC: 0.030 inch thick ultraviolet-resistant, limited to maximum 20 inch outside diameter of insulation. ASTM D 1784.
- B. EPDM Elastomeric Insulation: Factory applied, 30 mil thick PVC jacket.
- C. Standard Duty Factory Assembly: At Contractor option for PVC jacket described above, multi ply, 7 mil thick, flexible, self-adhering assembly as a protective jacket, vapor barrier and weatherproof membrane with acrylic adhesive on inside surface and white exterior finish. Jacket material with 0.000 water vapor permeance rating per ASTM E 96 Procedure B, and UV resistant. VentureClad Type 1577 CW Foster Vapor-Fas™ 62-05 or approved.
- D. Factory Applied Metal Jacket: At Contractor option, fiberglass or elastomeric pipe insulation with factory applied metal jacket for pipe sizes 2 inch and larger acceptable. Knauf Redi-Klad™ or approved.



PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, manufacturer's installation instructions and directions, and requirements described in NCIS. Where these may be in conflict, the more stringent requirements govern.

3.04 TIME OF APPLICATION

- A. General: Apply insulation only after piping and ducts have been pressure tested and certified by the A/E as ready for insulation. If insulation is applied prior to pressure testing, necessary removals, repairs, and modifications to insulation due to leaks that may occur shall be made at no additional cost to the Owner.
- B. Manufacturer's Instructions: Follow with regard to ambient temperature requirements and special techniques.

3.05 EXTENT OF INSULATION

- A. Insulate piping, conditioned air ductwork, and equipment, except as indicated in the Contract Documents.
- B. Do not Insulate the Following:
  - 1. Piping:
    - a. Valve handwheels and operators.
    - b. Trap primer piping downstream of trap primers except where buried.
    - c. Temperature/pressure test ports (Pete's Plugs).
    - d. Tempered water except for systems 100 F and above.
  - 2. Ducts:
    - a. Transfer, exhaust, and relief ducts except as specified in this section.
    - b. Return ducts in suspended ceiling spaces located within building insulation envelope.
    - c. Return ducts exposed in conditioned space.
    - d. Factory-insulated flexible ducts.

- e. Supply ducts exposed within a space that serves that space only.
  - f. Duct flexible connections.
3. Equipment:
- a. Items with factory-applied insulation meeting the requirements of this section.
  - b. Nameplates and ASME labels.
- C. Ducts Specified to Have Soundlining and Factory Soundlined Ducts: Refer to Section 233100. Need not be insulated unless additional insulation is required to meet thickness requirements of this section.

### 3.06 INSTALLATION, GENERAL

- A. Apply in a workmanlike manner by skilled workmen regularly engaged in this type of work.
- B. Apply to clean and dry surfaces.
- C. On cold piping and duct surfaces, apply with continuous, unbroken vapor barrier. Vapor seal seams with vapor barrier coating. Insulate and seal supports, anchors, and other projections and penetrations that are secured to cold surfaces with vapor barrier coating. Apply vapor stops or vapor dams at butt joints at every fourth pipe section joint and at each fitting.
- D. Extend surface finishes to protect raw edges, ends, and surfaces of insulation.
- E. Install piping and duct insulation continuous through walls, ceilings, and floor openings and sleeves, except where firestop materials are required.
- F. Install with joints tightly butted or adhered per manufacturer's requirements.
- G. Install insulation to allow access to equipment for inspection and repairs.
- H. Bevel and seal insulation around equipment nameplates and ASME labels.
- I. Do not allow fiberglass insulation to get wet or absorb moisture. Remove and dispose of wetted and moist fiberglass insulation and replace with new, dry material. Drying out wetted fiberglass insulation not acceptable.

### 3.07 PIPING SYSTEM INSULATION

- A. PVC Covers for Fittings and Valves: Seal circumferential edges by 2 inch minimum overlap onto adjacent pipe insulation using PVC tape or ASJ/SSL butt strip material.
- B. Glass Fabric and Vapor Barrier Finish for Below Ambient, Insulated Fittings and Valves: Lap 2 inch onto adjacent pipe insulation.
- C. Cold Piping:
  - 1. Secure fiberglass or elastomeric insulation ends with SSL butt strips, minimum 3 inch wide. Vapor seal ASJ seams with vapor barrier coating. Adhere elastomeric butt joints per manufacturer's requirements.

2. Secure joints and exposed ends at fittings, valves, and equipment with vapor barrier coating. Ensure that vapor barrier for insulation system is continuous from piping to exterior of system to prevent moisture migration into insulation envelope.
  3. Vapor seal joint connections to insulated pipe hangers specified in Section 232116.
  4. Install insulation on waste conveying condensate pipes which receive condensate from ice machines, condensate drain pans, and similar applications from floor drains, floor sinks, floor receptors, and roof receptors. Insulate from underside of drain to a point 5 feet downstream of trap or to connection to another waste pipe.
- D. Hot Piping:
1. Secure fiberglass or elastomeric ends with ASJ/SSL butt strips, minimum 3 inch wide. Secure ASJ laps and butt strips with suitable lap adhesive.
  2. Secure PVC covers with tacks, PVC tape, or solvent type PVC adhesive.
- E. Buried Piping Insulation:
1. General: Stagger and seal seams and joints for specified thickness.
  2. Bedding: Install in 4 inch thick sand bed.

### 3.08 DUCT SYSTEM INSULATION

- A. Cut insulation slightly longer than circumference of duct to insure full thickness at corners. Apply insulation with edges tightly stitched with staples. Tape stitched seam with 3 inch wide pressure sensitive aluminum foil or FSK tape or seal joints with 2 coats of vapor barrier mastic reinforced with one layer of open weave glass fabric.
- B. Secure insulation to bottom of rectangular and square ducts 18 inch and wider with welded pins and speed clips on 18 inch centers. Cut off protruding ends of the pins flush after speed clips have been installed. Seal vapor barrier facing where pins have pierced through with tape of same material by applying vapor barrier adhesive to both surfaces as recommended by manufacturer.
- C. Install fiberglass duct wrap with maximum 25 percent compression.
- D. Insulate exhaust ducts from exterior louver, roof cap, or similar termination, to a point 10'-0" into building or to backdraft or motor operated damper, whichever distance is less. Remaining exhaust ducts uninsulated.
- E. Seal other joints and penetrations of vapor barrier facing with 3 inch wide pressure sensitive aluminum foil or FSK tape and vapor barrier coating. Seal cuts and tears with strips of aluminum foil or FSK tape and apply vapor barrier coating.
- F. Rectangular transfer ducts will be fabricated with 1 layer of soundlining as specified in Section 233100.

### 3.09 EQUIPMENT INSULATION

- A. General:
  1. Form or fabricate insulation to fit equipment. Groove or score as required to closely conform to round surfaces. Bevel edges and tightly butt and stagger joints.
  2. Apply smooth coat of insulating cement over irregular surfaces.

3. Install removable insulation on heads of heat exchangers and other equipment requiring access for maintenance, repair, and cleaning. Fabricate removable section joints using a male-female shiplap type joint. Finish entire surface of removable section as specified in this section.
- B. Indoor to 450 F:
1. Secure with adhesive, fasteners, or bands. Locate fasteners maximum 3 inch from edges and spaced maximum 12 inch on center.
  2. Overlap vapor barriers minimum of 2 inch at seams and seal with pressure sensitive tape or weather barrier breather mastic.
  3. Cover penetrations, facing damage, and mechanical fasteners with minimum 2 inch overlap of tape or weather barrier breather mastic.
  4. When glass cloth and mastic is used, stretch glass cloth snugly to form smooth finished surface.

### 3.10 EXTENT OF EQUIPMENT INSULATION

- A. Insulate the following cold plumbing and cold HVAC equipment:
1. Air separators.
  2. Pipe unions.
  3. Strainers.
  4. Valves.
  5. Flanged joints.
  6. Domestic water booster package including piping and fittings.
- B. Insulate the following hot plumbing and hot HVAC equipment:
1. Pipe unions.
  2. Strainers.
  3. Valves.

### 3.11 JACKETING, FIELD APPLIED

- A. Jacketing Application: Install over insulation in the following locations:
1. Exposed piping and ducts in finished spaces and normally occupied areas. Locate jacket seams in least visible locations.
  2. Below 6 feet above finished floor in mechanical rooms.
  3. Piping located outdoors.
  4. Over calcium silicate insulation.
- B. PVC:
1. Overlap adjacent jacketing minimum 2 inch on down side to shed water. Weather seal using solvent type sealer.
  2. Install 6 to 10 inch unsealed slide joint every 25 to 30 lineal feet for thermal expansion of piping and jacketing. Install slide joint between fittings where distance exceeds 8 lineal feet.
  3. Seal riser long laps completely with solvent adhesive.
  4. Vapor seal cold pipe insulation prior to application and sealing of PVC jacketing. Seal seam edges and overlapping surfaces with vapor barrier coating. Overlap tape minimum 2 inch.

5. For hot pipe fittings, install layer of aluminum foil over first fiberglass or elastomeric insert, extending foil over adjacent pipe insulation. Apply second fiberglass or elastomeric insert over foil. Install PVC fitting cover over fiberglass or elastomeric inserts and seal with solvent adhesive along edges.
- C. Factory Assembly: Apply to pipe and duct insulation per manufacturer's installation instructions.

**3.12 COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

**3.13 EXTENT OF PIPE INSULATION**

- A. Insulate piping in accordance with the equipment schedules on the Contract Drawings.

**3.14 EXTENT OF DUCT INSULATION**

- A. Insulate ductwork in accordance with the equipment schedules on the Contract Drawings.
- B. Ducts Specified to Have Soundlining and Factory Soundlined Ducts: Refer to Section 233100. Need not be insulated unless additional insulation is required to meet thickness requirements of this section.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 08 00  
MECHANICAL SYSTEMS COMMISSIONING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes Divisions 22 and 23 responsibilities and participation in commissioning process to demonstrate compliance of mechanical systems in accordance with the Contract Documents.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, and Sections 230505, 230593, 230810, and 230820 apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Applicable energy code.
  - 2. ASHRAE Guideline 0, The Commissioning Process.
  - 3. ASHRAE Guideline 1, The HVAC Commissioning Process

**1.03 CONTRACTOR RESPONSIBILITIES FOR COMMISSIONING**

- A. General:
  - 1. Commissioning is responsibility of Divisions 22 and 23 subcontractors, their subcontractors, and their equipment suppliers.
  - 2. Divisions 22 and 23 subcontractors are responsible to provide support required for start-up, testing, and commissioning.
  - 3. Commissioning process requires that portions of the Work have been completed in satisfactory and fully operational manner.
  - 4. Include commissioning status during construction phase to monitor progress.
- B. Basic Commissioning Support:
  - 1. Within 30 days after contract award to the Contractor, prepare preliminary schedule in conjunction with the Commissioning Authority and the A/E for pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting and balancing, start-up and completion for verification by the Commissioning Authority. Include schedule in master project construction schedule. Update schedule as appropriate.

2. Give minimum 48 hours prior notice to the Commissioning Authority and the A/E when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting and balancing will occur. Be responsible to notify the Commissioning Authority and the A/E when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the Commissioning Authority and the A/E have scheduling information needed to efficiently execute commissioning.
3. Schedule start-up and testing of equipment and systems.
4. Assist in testing, adjusting, and balancing. Allow sufficient time before commissioning commences so that testing, adjusting, and balancing can be accomplished and deficiencies corrected.
5. Operate equipment and systems for commissioning tests.
6. Assign qualified personnel for participation in commissioning functional performance tests, including seasonal testing required after initial commissioning.
7. Complete pre-functional test checklists to assure that Divisions 22 and 23 equipment and systems are fully operational and ready for functional testing.
8. Assist in functional performance testing to verify equipment and system performance.
9. Furnish equipment, materials, and labor necessary to correct deficiencies found during commissioning process which fulfill contract and warranty requirements.
10. Prepare operations and maintenance information and Record Drawings.
11. Assist in developing system operation descriptions.
12. Schedule and arrange for training for systems specified.
13. Coordinate with equipment manufacturers to determine specific requirements to maintain warranties.
14. Correct deficiencies and submit signed documentation to the Commissioning Authority and the A/E that deficiencies have been corrected.
15. Provide support to the Commissioning Authority and the A/E to address requirements for U.S. Green Building Council Leadership in Energy Environmental Design.

## PART 2 - PRODUCTS

### 2.01 TEST EQUIPMENT

- A. Description: Test equipment as necessary for start-up and testing of mechanical equipment.
- B. Proprietary Test Equipment:
  1. For products in which proprietary test equipment is needed for functional performance testing, product manufacturer shall furnish test equipment, demonstrate its use, and assist the Commissioning Authority in commissioning process. Proprietary test equipment shall become property of the Owner upon completion of commissioning.
  2. Identify proprietary test equipment required in test procedures submittals and in separate list of equipment to be included in the Operations and Maintenance Manuals.

PART 3 - EXECUTION

3.01 WORK PRIOR TO COMMISSIONING

A. Description:

1. Complete all phases of the Work so various systems can be started, tested, adjusted, balanced, and otherwise commissioned. Submit written notification to the Owner's representative, the Commissioning Authority, and the A/E that systems have been calibrated, tested, are operating properly, and are ready for commissioning at least 14 days prior to scheduled commissioning.
2. Divisions 22 and 23 subcontractors have primary start-up responsibilities with obligations to complete systems, including sub-systems, so they are fully functional. This includes complete installation of equipment, materials, pipe, duct, wire, insulation, controls, and similar items per the Contract Documents and related directives, clarifications, and change orders.

B. Commissioning Plan:

1. The Commissioning Authority will develop the Commissioning Plan. Assist the Commissioning Authority in preparing commissioning plan by submitting necessary information pertaining to actual equipment and installation.
2. Make system modifications and clarifications in contractual requirements of this and related sections of work at no additional cost to the Owner.
3. If general contractor-initiated system changes have been made that alter commissioning process, the Commissioning Authority will notify the Owner.

C. Pre-Commissioning Work:

1. Attend a commissioning scoping meeting and other meetings necessary to facilitate the commissioning process. One representative of the Division 23 subcontractor cognizant of aspects of Division 23 work shall attend commissioning meetings. Other trades shall attend commissioning meetings when their portions of the Work are being tested.
2. Start-up and testing services for equipment, including but not limited to the following:
  - a. Air-handling and distribution equipment.
  - b. Heating equipment.
  - c. Cooling equipment.
  - d. Plumbing equipment.
  - e. Controls.
3. Normal start-up services required to bring each system into a fully operational state. This includes cleaning, filling, purging, leak testing, motor rotation check, control sequences of operation, full and part load performance, and similar conditions.
4. The Division 22 and 23 subcontractors shall perform pre-functional tests on equipment and systems. Pre-functional checklists will be written by the Commissioning Authority.
5. Completion of controls installation, calibration, programming, and testing is critical for efficient and successful commissioning process.
6. The Commissioning Authority will not begin commissioning process until each system is complete, including normal contractor start-up.



- D. Scheduling: Commissioning is intended to begin upon completion of each system. Commissioning may proceed prior to completion of systems and sub-systems subject to coordination with the Commissioning Authority. Starting of commissioning before system completion will not relieve Divisions 22 and 23 subcontractors from completing those systems per construction schedule.

### 3.02 PARTICIPATION IN COMMISSIONING

- A. Description:
1. Start-up and testing of systems specified in Divisions 22 and 23 by skilled technicians. Make these same technicians available to assist the Commissioning Authority in completing commissioning program as it relates to each system and their technical specialty.
  2. Coordinate work schedules, time required for testing, and similar conditions with the Commissioning Authority. Ensure that qualified technicians are available and present during agreed upon schedules and for sufficient duration to complete necessary tests, adjustments, and problem resolutions.
- B. System Problems and Discrepancies: These may require additional technician time, redesign, and reconstruction of systems and system components. Make additional technician time available for subsequent commissioning periods until required system performance is obtained.
- C. Qualifications of Technicians: The Commissioning Authority and the A/E have right to judge appropriateness and qualifications of technicians relative to each item of equipment or system. Qualifications of technicians include expert knowledge relative to specific equipment involved, adequate documentation and tools to service/commission equipment, and attitude and willingness to work with the Commissioning Authority and the A/E to get the Work done.
- D. Functional Performance Test: Initial Functional Performance Test procedures will be written by the Commissioning Authority. Assist the Commissioning Authority in developing final Functional Performance Tests. Perform final Functional Performance Tests.

### 3.03 WORK TO RESOLVE DEFICIENCIES

- A. Description:
1. In some systems, misadjustments, misapplied equipment, and deficient performance under varying loads will result in additional work being required to commission systems. Complete Work under direction of the Commissioning Authority with input from appropriate subcontractor and equipment supplier.
  2. Whereas members will have input and opportunity to discuss the Work and resolve problems, the A/E will have final authority on necessary work to be done to achieve performance.
- B. Timing:
1. Complete corrective work to permit completion of commissioning process.
  2. Experimentation to achieve system performance permitted. If the Commissioning Authority deems experimentation work is ineffective or untimely as it relates to commissioning process, the Commissioning Authority will notify the Owner indicating nature of problem, expected steps to be taken, and deadline for completion of activities.

3. If deadlines pass without resolution of the problems, the Owner reserves right to obtain supplementary services and equipment to resolve problems. Costs incurred to solve problems in an expeditious manner will be Divisions 22 and 23 subcontractors' responsibilities.

#### 3.04 ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after system adjustments, replacements, and similar activities are completed. Divisions 22 and 23 subcontractors and their suppliers shall include a reasonable reserve to complete this work as part of their standard contractual obligations.

#### 3.05 DEFERRED TESTS FOR SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS

- A. Description:
  1. Seasonal commissioning pertains to testing under full load conditions during peak heating and peak cooling seasons, as well as under part load conditions in non-peak seasons.
  2. Perform initial commissioning as soon as the Work is completed regardless of season. Subsequent commissioning may be undertaken any time thereafter to ascertain adequate performance during different seasons.
  3. Occupancy tests are tests that require full load conditions associated with normal occupancy and use of the Work. Occupancy tests may need to be deferred until such time as specified load conditions exist after occupancy.
- B. Peak Seasons:
  1. Test and commission equipment and systems in a peak season to observe full load performance.
  2. Test heating equipment during winter design extremes.
  3. Test cooling equipment during summer design extremes with building fully occupied and operating.
  4. Divisions 22 and 23 subcontractors are responsible to participate in initial and alternate peak season test of systems required to demonstrate performance as scheduled by the Commissioning Authority with minimum 3 day advance notification.
- C. Non-Peak Seasons:
  1. Subsequent commissioning may be required under conditions of minimum and maximum occupancy or use.
  2. Equipment and systems affected by occupancy variations may be tested and commissioned at minimum loads to observe system performance.
  3. Divisions 22 and 23 subcontractors are responsible to participate in occupancy sensitive testing of systems to provide verification of adequate performance.

#### 3.06 FIRE SUPPRESSION, PLUMBING, AND HVAC SYSTEMS TRAINING

- A. Comply with requirements in Section 230810:
  1. Participate in training of the Owner's engineering and maintenance staff on each system and related components, as required in Divisions 01, 22, and 23 sections.
  2. Conduct training in classroom setting with system and component documentation and suitable classroom training aids.

3. Conduct field training as necessary to facilitate instruction on specific equipment and systems.
4. Conduct training jointly with the Commissioning Authority, Division 22 and 23 subcontractors and their subcontractors, and equipment vendors. The Commissioning Authority will be responsible for highlighting system peculiarities specific to this project.

3.07 **SYSTEMS DOCUMENTATION**

- A. Drawings: Maintain as-built red-lines as required in Division 01 and Section 230500.
- B. Operations and Maintenance Data: Comply with requirements in Section 230820. Submit one copy of equipment technical literature, operations and maintenance literature, and shop drawings as soon as they are available. This requirement is for review of documents prior to distribution of multiple copies for the Owner's final use.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 08 10  
SYSTEMS TRAINING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes training the Owner's personnel in operation, maintenance, and management of fire suppression, plumbing, and HVAC systems.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 SCOPE OF WORK**

- A. Fire suppression, plumbing, and HVAC systems training shall be both classroom and field sessions to introduce operation, maintenance and management personnel to Operations and Maintenance Manuals, drawings, and other documents and aids available to operate and maintain equipment. Training shall occur following installation of fire suppression, plumbing, and HVAC work and prior to final acceptance. Commence instruction periods with approved Operations and Maintenance Manuals.
- B. Factory trained specialists in area of major equipment and system shall present sessions on their specific equipment and system. For control systems specified in Section 230900, representative shall be the technician who performed testing and adjustment.
- C. Conduct extensive hands-on training during fire suppression, plumbing, and HVAC systems preliminary commissioning so that actual operations and maintenance of equipment and systems could be the responsibility of operation, maintenance and management personnel at completion of preliminary commissioning if the Owner so chooses. Conduct instructions in appropriate sessions. Comply with total minimum hours specified in individual specification sections.
- D. Video record training sessions with emphasis of video subject and hands-on equipment operation. Following training sessions, deliver 2 copies of CD/DVD to the Owner.

**1.03 VISUAL AIDS**

- A. Utilize visual aids, such as slides, video, and movies. Visual aids shall be made a part of the Owner's permanent files.

**1.04 TRAINING TIME ALLOWANCE**

- A. General: Include in Bid total hours listed below for each section. Refer to specific section for additional training requirements.
  - 1. DIVISION 21:
    - a. SECTION 211000 AUTOMATIC FIRE SUPPRESSION SYSTEMS: Total of 2 hours.
    - b. SECTION 213000 FIRE PUMPS: Total of 2 hours.

2. DIVISION 22:
  - a. Section 221116 Domestic Water System: Total of 1 hour.
  - b. SECTION 221120 PLUMBING VALVES: Total of 1 hour.
  - c. SECTION 221123 PLUMBING PUMPS: Total of 1 hour.
  - d. SECTION 221300 SOIL, WASTE, VENT, AND STORM DRAIN SYSTEM: Total of 1 hours.
  - e. SECTION 221500 COMPRESSED AIR PIPING SYSTEMS: Total of 2 hours.
  - f. SECTION 223000 PLUMBING EQUIPMENT: Total of 2 hours.
  
3. DIVISION 23:
  - a. SECTION 230800 MECHANICAL SYSTEMS COMMISSIONING: Total of 20 hours.
  - b. SECTION 230900 AUTOMATIC TEMPERATURE CONTROLS: Total of 24 hours.
  - c. SECTION 232300 REFRIGERANT PIPING: Total of 1 hour.
  - d. SECTION 233100 AIR DISTRIBUTION: Total of 1 hour.
  - e. SECTION 233300 AIR DISTRIBUTION ACCESSORIES: Total of 2 hours.
  - f. SECTION 233400 AIR DISTRIBUTION EQUIPMENT: Total of 4 hours.
  - g. SECTION 234100 FILTERS: Total of 1 hour.
  - h. SECTION 238100 PACKAGED HVAC EQUIPMENT: Total of 4 hours.
  - i. SECTION 238200 TERMINAL HEAT TRANSFER EQUIPMENT: Total of 2 hours.

## PART 2 - PRODUCTS

Not Used.

## PART 3 - EXECUTION

### 3.01 FIRE SUPPRESSION, PLUMBING, AND HVAC SYSTEMS TRAINING

- A. General: Operator training shall provide a complete overview of equipment, components, and systems with an emphasis on:
  1. Documentation in the preliminary Operations and Maintenance Manuals.
  2. How to use the Operations and Maintenance Manuals.
  3. System operational procedures for all modes of operation, including warm-up, cool-down, occupied, unoccupied, start-up, shut-down and similar cycles.
  4. Acceptable tolerances for system adjustments in operating modes including noise and vibration adjustments and economy and efficiency adjustment.
  5. Procedures for dealing with abnormal conditions including emergency operations.
  6. Hazards and safety.
  7. Automatic temperature control sequences of operation.
  8. Review of maintenance and operations in relation to written applicable warranties, agreements to maintain and service and similar continuing commitments.
  9. Seasonal de-commission and re-commission.
  
- B. Schedule: Submit training schedule and agenda to the A/E and the Owner for approval 4 weeks prior to first training session.

- C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain equipment, systems, and subsystems. Furnish educational materials and tools needed to conduct training sessions.
- D. Typical Agenda as Follows:
1. Opening remarks.
  2. Introduction.
  3. Description of HVAC Systems:
    - a. Air Side:
      - 1) Cooling.
      - 2) Heating.
      - 3) Ventilation.
      - 4) Life safety.
    - b. Wet Side:
      - 1) Cooling.
      - 2) Heating.
  4. Description of HVAC Equipment and Systems (Individual Suppliers Shall Discuss Equipment):
    - a. Wet Side:
      - 1) Refrigeration Equipment:
        - a) Accessory equipment.
        - b) Electrical.
        - c) Control.
        - d) Refrigerant piping.
      - 2) Insulation.
    - b. Air Side:
      - 1) Heat Recovery Units, Dedicated Outside Air Units and Fans:
        - a) Fans.
        - b) Coils.
        - c) Heat exchangers.
        - d) Controls.
        - e) Electrical.
        - f) Vibration isolation.
        - g) Insulation.
      - 2) Duct System:
        - a) Type(s).

- c. Pressure Controls:
  - 1) System type.
  - 2) Purpose.
  
- 5. Description of Plumbing Equipment and Systems:
  - a. Piping and valves.
  - b. Water heaters.
  - c. Domestic water booster packages.
  - d. Expansion tanks.
  - e. Pumps.
  - f. Plumbing fixtures.
  - g. Plumbing fixture faucets and flush valves.
  - h. Trap primers.
  
- 6. Description of Fire Suppression Systems:
  - a. Alarm valve assemblies.
  - b. Piping and valves.
  - c. Fire pumps.
  - d. Valve tamper switches.
  - e. Review of NFPA 25.
  
- 7. Walk-through of building (project).
- 8. Start-up Procedures:
  - a. Seasonal considerations.
  - b. Check list.
  - c. Emergency procedures.
  
- 9. Operation Procedure:
  - a. Occupancy considerations.
  - b. Seasonal considerations (changeover).
  - c. Manual/automatic.
  - d. Emergency.
  
- 10. Shut Downs:
  - a. Check list.
  - b. Normal.
  - c. Emergency.
  - d. Alarms and resets.
  
- 11. Maintenance of HVAC, Fire Suppression, Plumbing, and HVAC Systems:
  - a. Routine.
  - b. Preventive.
  - c. Service.
  - d. Lubrication.
  - e. Overhaul.
  - f. Factory.
  - g. Cleaning.

- h. Access provisions.
- 12. Warranties:
  - a. What they cover.
  - b. How to use them.
- 13. Spare Parts.
- 14. Tools:
  - a. Normal tools, supplies and equipment.
  - b. Special tools.
- 15. Hands-on operation of fire suppression, plumbing, and HVAC system equipment in conjunction with preliminary commissioning.
- 16. Sequence of operation of fire suppression, plumbing, and HVAC system during fire emergency.
- 17. Smoke Dampers: Describe maintenance requirements for and demonstrate testing of fire dampers and ceiling radiation dampers in accordance with NFPA 80, Standard for Fire Doors and Other Opening Protectives and for smoke dampers in accordance with NFPA 105, Standard for Smoke Door Assemblies and Other Opening Protectives.

### 3.02 RETRAINING

- A. After fire suppression, plumbing, and HVAC system commissioning, instruct Owner's operations and maintenance personnel on changes and reconfiguration which may have occurred during commissioning process.

\*\*\*END OF SECTION\*\*\*



**SECTION 23 08 20**  
**SYSTEMS OPERATIONS AND MAINTENANCE MANUALS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes preparation of mechanical systems Operations and Maintenance Manuals.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 SCOPE OF WORK**

- A. General:
  - 1. Comply with requirements in Division 01 with additional requirements indicated in this article. Provide 2 hard copies and an electronic copy.
  - 2. For each component and systems listed in Article "Table of Contents" in this section and furnished and installed by the Contractor, include the following (both in hard and electronic format). Include a basic description of systems.
- B. Product Data and Parts List: Include local source of supply for parts and replacement. List parts and components of equipment stating catalog number (serial number and ratings, such as HP, voltage, and GPM.) and size of part used in or on equipment. Include information pertinent to specific project and annotate each page to clearly identify specific product or part installed and identify data applicable to installation. Delete references to inapplicable information.
- C. Master Preventive Maintenance Schedule and Procedures: Include safety precautions and safety features.
- D. For Equipment and Components:
  - 1. Troubleshooting Guide: Include equipment functions, operating characteristics, and limiting conditions.
  - 2. Manufacturer's Installation Instructions: Include assembly, installation, wiring diagrams, alignment, adjustment, and checking instructions.
  - 3. Manufacturer's Service Instructions. Include suggested frequency of maintenance and list of lubricants.
  - 4. Start-up Instructions with Certificates of Start-up and Verification: Include test data and performance curves, routine and normal operation, regulation and control, shutdown and emergency conditions.
  - 5. Final approved submittals.
- E. Warranties: Copy of each warranty, guarantee, bond, and maintenance/service contract issued. Include information for the Owner's personnel indicating proper procedures in event of failure and instances which might affect validity of warranties. State warranty start date and duration of components.

- F. Maintenance and service contracts (if specified).
- G. Final testing, adjusting, and balancing reports.
- H. Filters: Include sizes, quantities, and locations.
- I. Belts: Include sizes, quantities, and locations.
- J. Fuses: Include list.
- K. Video record main underground waste piping and furnish a copy of CD/DVD to the Owner.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Submit preliminary copy of the Operations and Maintenance Manual in 1 package. Incomplete, "piece-meal" submittals not acceptable and will be returned unreviewed.
- C. Submit completed preliminary copy of Operations and Maintenance Manuals to the A/E for review and approval. Submit approved Operations and Maintenance Manuals to the Owner minimum 30 days before instruction periods as specified in Section 230810. Commence with review comments and corrective measures identified during these procedures being incorporated. Following instruction periods, incorporate corrective measures and submit final Operations and Maintenance Manuals.
- D. Final Operations and Maintenance Manuals in both hard and electronic formats.

**1.04 TABLE OF CONTENTS**

- A. Warranty
- B. Preventative Maintenance Schedule
- C. Filter List
- D. Belt List
- E. Fuse List
- F. Valve Location Drawings
- G. Final TAB Report
- H. DIVISION 21 - Fire Suppression:
  - 1. Grooved piping and couplings.
  - 2. Valves.
  - 3. Sprinkler heads.
  - 4. Alarm valve assemblies.
  - 5. Water flow detectors.
  - 6. Air compressors.
  - 7. Fire pump system

I. DIVISION 22 - Plumbing:

1. Fixtures.
2. Flush valves.
3. Faucets.
4. Valves.
5. Water heaters.
6. Domestic water booster package.
7. Expansion tanks.
8. Hose bibbs and wall hydrants.
9. Trap primers.
10. Pumps.
11. Compressed air system.

J. DIVISION 23 - HVAC:

1. Heat recovery units.
2. Dedicated outside air units.
3. Fan coil units.
4. Heat pumps.
5. Variable air volume (VAV) units.
6. Packaged HVAC equipment.
7. Pressure switches.
8. Backdraft dampers.
9. Fans.
10. Electric duct heaters.
11. Smoke dampers.
12. Temperature Controls:
  - a. Thermostats and temperature sensors.
  - b. Other sensors.
  - c. Sequences of operation with final setpoints.
  - d. As-built wiring diagrams including line and low voltage wiring between field components and HVAC control panels and equipment control panels.
  - e. Point-by-point system verification checklist.
  - f. DDC programming diagrams.
  - g. Central operator workstation functions with specific software programming for installed systems.
  - h. Control dampers.
  - i. Actuators.
  - j. Airflow measuring units.
  - k. Equipment.
  - l. Power backup.
  - m. Floor plans of building with locations of controllers, actuators, sensors and transformers.
  - n. Floor plans of building with location of equipment and their controls.
  - o. Spread sheet showing points and controls associated with piece of equipment and location of power source.

PART 2 - PRODUCTS

2.01 **FORMAT**

- A. Submit preliminary Operations and Maintenance Manual to the A/E in hard copy format for review and approval.
- B. Submit final Operations and Maintenance Manual to the A/E and the Owner in both hard copy and electronic format.
  - 1. Hard Copy: Assemble Operations and Maintenance Manual in 3-ring binder(s). Use multiple binders if pages in a single binder would exceed 2-1/2 inch thickness. Separate binders for each category, such as Division 21 Fire Suppression, Division 22 Plumbing, and Division 23 HVAC. Where one subject matter encompasses more than one binder, differentiate by volume numbers. Include indexed tabs for each binder.
  - 2. Electronic Copy: Assemble Operations and Maintenance Manual in one single Adobe PDF with bookmarks for each division, specification number, and part number.
- C. The Operations and Maintenance Manual shall be provided also in electronic format (Excel, Word, and Bitmap). Performance data shall be in spreadsheet format and operation startup and troubleshooting information shall be in Word document. Diagrams shall be in bitmap format. Assemble AutoCAD drawings so that X-refs are automatically attached.
- D. Fold drawings to 8-1/2 by 11 inch size and bind as above (with reinforcing at punched holes) or place in clear plastic holder designed for 3-ring binders.
- E. Identify on cover and spine for each binder with printed title such as "FIRE SUPPRESSION", "PLUMBING", or "HVAC" OPERATIONS AND MAINTENANCE MANUAL", names of project, Owner, general contractor, subcontractor, Architect, mechanical engineer, and year of project completion.
- F. Include in each binder and volume material specified in Articles "Scope of Work" and "Table of Contents" in this section for ease of reference and use. Binders shall have a commercial quality stiff cover, metal-hinged, with durable and cleanable plastic covers.
- G. Include overall table of contents of items submitted organized by system (not by specification section).
- H. Include heavy, tabbed divider sheet for each category with title on tab. Include table of contents for category, including catalog numbers or drawings numbers if appropriate.
- I. Include names, addresses and phone numbers of equipment suppliers.
- J. Include Record Drawings reduced proportionately.

PART 3 - EXECUTION

Not used.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 09 00**  
**AUTOMATIC TEMPERATURE CONTROLS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes design, components, hardware, and construction for complete installation of operational Direct Digital Control (DDC) system. The Work includes integration of the DDC system into the Tridium Niagara Framework Supervisor and Niagara Workbench located at Federal Way City Hall (33325 8th Ave S, Federal Way, WA 98003).
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.
- C. Extent: Provide new system including associated equipment and accessories. Provide control system complete and operating as required by the Contract Documents. Manufacturer's products, including design, materials, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with NFPA 70, except as indicated otherwise on the Drawings and this section.
- D. Although such work is not specifically indicated on the Drawings or in this section, include supplementary and miscellaneous items, appurtenances, and devices incidental to or necessary for sound, secure, and complete operating installation.

**1.02 SYSTEM DESCRIPTION**

- A. The Integration Platform shall include, but not be limited to, the following components/sub systems to provide a fully functional platform required for integrating the systems.
  - 1. Honeywell Niagara 4 Supervisor.
  - 2. Honeywell Niagara 4 Workbench.
  - 3. Associated Niagara drivers and applications.
  - 4. Niagara based hardware platforms (JACE 9000 / Spyder 7 / CIPer 10-30-50 controllers).
  - 5. Installation, engineering, programming, and commissioning.
- B. The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.
- C. Provide all labor, materials, and equipment necessary for a complete and operating Integration Platform, utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section shall communicate on a peer-to-peer bus over an open protocol bus (Examples: LonTalk, BACnet, MODBUS). Submit a Data Plan that includes database standards, graphics, dashboards, data tagging and program guidelines for the Engineer's review.
- D. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet MSTP, IP and MODBUS.

- E. System architecture shall provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any designated computer on the owner's LAN.
- F. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset for this project. The use of configurable or programmable controllers that require additional software tools or tools that require a specific Niagara 4 license brand to operate for post-installation maintenance shall not be acceptable.
- G. Any control vendor that shall provide additional BMS server software shall be unacceptable. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section.
- H. The integration platform server shall host all graphic files for the control system. All graphics and navigation schemes for this project shall match those that are on the Niagara 4 Framework server.
- I. Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the Building Management System (BMS).
- J. OPEN NIC STATEMENTS - All Niagara 4 software licenses shall have the following NiCS: "accept.station.in=\*"; "accept.station.out=\*"and "accept.wb.in=\*"and "accept.wb.out=\*". All open NIC statements shall follow Niagara Open NIC specifications.
- K. All JACE hardware licenses and certificates shall be stored on local MicroSD memory card encrypted "safe boot" CPU technology.
- L. All IP-based controllers shall employ encrypted "safe boot" CPU technology.
  - 1. JACE 9000 / Spyder 7 / CIPer 10-30-50 controllers.

### 1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Applicable energy code.
  - 2. AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating.
  - 3. AMCA Publication 511, Certified Ratings Program – Product Rating Manual for Air Control Devices.
  - 4. ANSI C12.10, Physical Aspects of Watt hour Meters – Safety Standard.
  - 5. ASHRAE Standard 135 (BACnet).
  - 6. ASHRAE BACnet Protocol Standard.
  - 7. ASME B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through 24 inch Standard.
  - 8. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - 9. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - 10. ASME B16.26, Cast Copper Alloy Fittings for Flared Tubes.
  - 11. ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - 12. ASTM B 32, Standard Specification for Solder Material.

13. ASTM B 75, Standard Specification for Seamless Copper Tube.
14. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
15. ASTM B 280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Services.
16. BACnet Testing Laboratories (BTL).
17. CSA, Canadian Standards Association.
18. FCC, Part 15, Subpart B, Class B.
19. FCC, Part 15, Subpart C.
20. FCC, Part 15, Subpart J, Class A Computing Devices.
21. IEEE C57.13, IEEE Standard Requirements for Instrument Transformers.
22. NFPA 70, National Electrical Code.
23. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
24. UL 504 - Industrial Control Equipment.
25. UL 506, Standard for Specialty Transformers.
26. UL 873, Standard for Temperature-Indicating and -Regulating Equipment.
27. UL 910 - Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces.
28. UL 916, Standard for Energy Management Equipment.
29. UL 1449, Standard for Surge Protective Devices.
30. UL 61010B-1, Electrical Measuring and Test Equipment; Part 1: General Requirements.

#### 1.04 CONTROL SYSTEM SUBCONTRACTOR REQUIREMENTS

##### A. Qualifications:

1. Experience in implementing Niagara Framework projects size and scope.
2. Must have a successful history in the design and installation of Niagara Framework projects.
3. Must have 5 years consecutive licensing capabilities with the Niagara Framework.
4. Must have minimum of 2 employed individuals who meet requirements per individual (Section D. Specific Requirements).
5. Firms shall have specialized in and be experienced with the installation of the Niagara Framework for not less than five years from date of final completion on at least three (3) projects of similar size and complexity. Submittals shall document this experience with references.
6. The City of Federal Way reserves the right to require bidding contractors to possess certain minimum qualifications necessary to deliver fundamental HVAC controls and energy services. The following evaluation chart is designed to assist the City of Federal Way with selecting the most qualified contractor.

B. Specific Requirements (Per Individual):

QUESTION	ANSWER YES OR NO	YES = MAX POINT NO = ZERO POINTS	POINT TOTALIZATION
1. Do you have a Controls Service Department with Dedicated Controls Specialists? (ONLY for service tasking)		20	
2. Is your company an approved Energy Service Company (ESCO) with the State of Washington?		15	
3. Does your company provide a turnkey project with dedicated Controls, Engineering, and Electrical Installation Personnel?		10	
4. Do you subcontract any or all of the tasks listed in Question #3?		10	
5. Are you able to support Honeywell WEBS or Siemens TALON Niagara hardware and software?		10	
6. Is your company an approved Honeywell ACI contractor or an ELITE Siemens TALON Contractor?		15	
7. Does your company have experience with Washington State Clean Building Standard, HB#1257		20	

1. Must have 3 years' experience with the firm represented.
2. Proof of Niagara 4 TCP Certification.
3. List and describe a Niagara Enterprise (more than one building) integration project and the programmer's involvement.
4. List and describe a Niagara integration project involving multiple communication protocols or databases.
5. List and describe a Niagara integration project involving multiple platforms such as HVAC, Lighting Control, Security, Life Safety, Utilities and other building control and or monitoring systems.

C. Control System Support:

1. System subcontractor's office within 50 miles of the job site. The office shall be staffed with applications engineers, software engineers and field technicians. This office shall maintain parts inventory and shall have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment.
2. Subcontractor shall respond to job site within 4 hour period for emergencies relating to control system.
3. Emergency response is defined as having a technician actively troubleshoot and correct problem either at job site or via internet connection to system.



- D. Single Source Responsibility: The control system subcontractor shall be responsible for the complete installation and proper operation of the control system. The control system subcontractor shall exclusively be in the regular and customary business of design, installation, and service of computerized building management systems similar in size and complexity to the system specified.
- E. Standard Products:
1. Material and equipment standard products of manufacturer regularly engaged in manufacturing of such products. Standard products shall have been in commercial or industrial use for 1 year prior to bid opening. One year use shall include applications of similarly sized equipment and materials used under similar circumstances.
  2. Equipment items shall be supported by installing controls contractor.
- F. Installation: System designed and constructed by authorized representative of product manufacturer. Carefully investigate mechanical, electrical, and finish conditions that could affect work to be performed, and contractor shall be capable of providing materials and labor necessary to meet such conditions.
- G. BACnet Compatibility: Furnish totally native BACnet system such that central operator workstation, global controllers, logic controllers, and input/output devices communicate using protocols and Local Area Network (LAN) standards as defined by ASHRAE Standard 135, BACnet. Workstations and controllers, including unitary controllers, shall be compatible native BACnet devices. No gateways shall be used. Entire processing system shall comply with ASHRAE Standard 135. DDC system shall use BACnet protocols and LAN types throughout and exclusively. Non-BACnet-compliant or proprietary equipment or systems (including gateways) not acceptable.

#### 1.05 SUBMITTALS

- A. General: Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
1. Control System Subcontractor Qualifications
  2. Control system hardware.
  3. Control system software.
  4. Network and network communications.
  5. Sensing and control devices.
  6. Control Valves, Dampers, Actuators.
  7. Auxiliary components.
  8. Surge protection for DDC systems.
  9. Electric power and distribution.
  10. Control wiring.
- C. Shop Drawings:
1. General: After approval of product data, submit Shop Drawings. Label components with tag numbers. Include index of symbols and abbreviations. Do not commence installation until Shop Drawings are accepted by the A/E.

2. Schematic Diagrams:
  - a. Include for each system (for example, fan system, pumping system, process) showing controls, relays, motor starters, contactors, control valves, actuators, switches, and associated components.
  - b. Indicate instrument settings.
  - c. Indicate field wiring and interconnecting equipment and devices.
  - d. Identify type and size of wire and assign unique numbers or colors to every wire.
  - e. Identify equipment and devices by reference designators. Include materials list on each drawing.
  - f. Block diagrams and schematics showing layout of computers, controllers, communication cabling, wire type, count and conduit fill.
  - g. Schematic showing general mechanical system layout with sensors/devices of each mechanical system shown with corresponding detail and labeling.
  - h. Include items not specified herein or indicated on the Drawings but necessary to perform functions in sequences of operation for a complete and operational control system.
3. Floor Plans: Indicate locations of systems, equipment, components, and wiring. Identification consistent with nomenclature used in other documentation.
4. Sequences of Operation:
  - a. Include narrative description for each system based on vendor's implementation of control logic.
  - b. Include initial values of variables. Variables described as user adjustable shall also be available for adjustment at operator workstation.
  - c. Sequences of operations shall describe not just what equipment does, but also how equipment achieves its desired performance.
  - d. Sequences of operation shall also be available as text file on central operator workstation.
5. Surge Protection for DDC System: Indicate details of devices and their installations.
6. DDC Panels: Submit physical layout and schematics including diagram of terminal strips, terminal strip locations, termination numbers and associated point names. For each input and output physically connected to a digital controller, include, on a controller by controller basis, the following:
  - a. Point Description: For example, mixed air temperature, supply fan start/stop, and similar points.
  - b. Point Type: Analog Output (AO), Analog Input (AI), Digital Output (DO), Digital Input (DI).
  - c. Point Range: For example, 4 to 20 mA.
  - d. Sensor Range Associated with Point Range: For example, 0 F to 100 F, 0 to 2 inch w.g.
  - e. Software names associated with each point.
  - f. Software address of each connected point to which each point is connected.
7. Graphics: Provide for each type of screen, including floor plans, elevations, system, and equipment. Submit at least one month before graphics implementation.
8. Typical Wiring Diagrams:
  - a. Indicate internal wiring of control panels.

- b. Indicate general physical arrangement of component devices installed in control panels.
  - c. Include elementary ladder diagrams to show function of circuits employing switching logic.
  - d. Include panel schedule show in location, systems served and point count.
  - e. Indicate DDC sensor and control wiring and installation diagrams for each type of input and each type of output device.
- D. DDC Software Data: Submit descriptions of system, command, and applications software.
- E. DDC Point List: Submit complete input/output summary (“point list”) to document system points and their associated functions as required by sequences of operation indicated on the Drawings. Include control points, monitoring points, and alarm points.
- F. Qualifications: Submit documentation as defined under Paragraph “Control System Subcontractor’s Qualifications”.
- G. Smoke Dampers: Submit documentation that controls subcontractor has reviewed and confirmed configuration of actuator location prior to dampers and actuators being ordered.
- H. ASHRAE Standard 135: Submit Protocol Implementation Conformance Statements (PICS).
- I. Control System Field Test Documentation:
- 1. Functional Tests: Submit test report forms demonstrating compliance with Article “Field Testing and Verification”. Documentation shall consist of expected and actual response of sensors, actuators, and controllers. Submit documentation of control loop stability and accuracy, proper execution of sequences of operation, and proper operation of equipment interlocks.
- J. Record Documents:
- 1. General: Submit Shop Drawings for each control system showing installed condition. As a minimum, include diagrams and documents listed in Paragraph “Shop Drawings” with sequences of operation. Include test report forms specified in Paragraph “Control System Field Test Documentation”. Submit documents in commonly readable and modifiable formats. Drawings in AutoCAD “.dwg” format. Other documents in Microsoft “.xls” or “.doc” formats acceptable. Include controller databases, graphics databases, and server and operator workstation configuration files.
  - 2. Flow Charts and Wiring Diagrams: Include in 11 inch x 17 inch size, laminated, and bundled with “ring”. Locate entire bundled set at central operator workstation. In addition, for specific diagrams, locate at their respective enclosure.

**1.06 DDC SYSTEM OPERATIONS AND MAINTENANCE MANUAL**

- A. General: Comply with requirements in Division 01 and Sections 230500 and 230820. Include the following:
- 1. Functional design.
  - 2. Hardware.
  - 3. Software.
  - 4. Operation.
  - 5. Maintenance.

- B. Functional Design: Operational requirements of system, theory of operation, design philosophy, and specific functions. Include description of hardware and software functions, interfaces, and requirements for system operating modes.
- C. Hardware:
  - 1. General description and specifications.
  - 2. Installation and checkout procedure.
  - 3. Equipment electrical schematics and layout drawings.
  - 4. System schematics and I/O wiring lists.
  - 5. Alignment and calibration procedures.
  - 6. Manufacturer's repair parts list indicating sources of supply.
  - 7. Interface definition.
- D. Operation: Procedures and instructions for operation of system. Include the following:
  - 1. System start-up and shut-down.
  - 2. Use of system, command, and applications software.
  - 3. Alarm presentation.
  - 4. Recovery and re-start procedures.
  - 5. Use of report generator including trend logs.
- E. Maintenance: Descriptions of maintenance for equipment including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.
- F. Shop Drawings: Include in both hard copy and in CD/DVD or USB drive formats.

**1.07 DDC SYSTEM SOFTWARE**

- A. General: Include licenses and registration cards for included software, device drivers, and peripherals.

**1.08 DDC DATABASE**

- A. General: Develop and implement database for DDC points and controls required for sequences of operation and point monitoring. Designate person with 2 years minimum experience in database generation procedures of DDC system for this purpose.
- B. Data: Prepare data entry forms utilizing data from the Contract Documents, field surveys, and other pertinent information required for complete installation of database. Identify and request from the Owner any additional data needed to provide complete and operational DDC system including, but not limited to, proper room identification information and scheduled hours of occupancy. Submit forms requesting this additional information to the Owner at least 60 days prior to need for such information.

**1.09 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION**

- A. Section 233300 – Air Distribution Accessories: Variable air volume (VAV) terminal box controllers and actuators for installation at factory by terminal unit manufacturer.
- B. Section 233300 – Air Distribution Accessories: Motorized dampers. Supervision of installation of these components by Control system subcontractor.

**1.10 RELATED WORK**

- A. Testing, Adjusting, and Balancing (TAB) Work:
  - 1. Furnish 16 hours personnel to TAB organization specified in Section 230593 to provide adjustments to control system for setup of TAB work. Adjustments to control system following completion of TAB work shall maintain settings of TAB work.
  - 2. Include services of DDC system start-up technician for 8 hours to operate DDC system during capacity tests, flow tests, minimum outdoor airflow tests, and other tests for which TAB work requires adjustments to DDC system.
  - 3. For DDC terminal unit controls, include start-up technician support and hand held operator's terminal to TAB organization. Assist and train TAB technicians on terminal unit controllers.
  - 4. Fine tune controls after TAB work is complete.
- B. Plumbing Equipment, Air Distribution Equipment, and Packaged HVAC Equipment Work.
  - 1. Furnish 8 hours personnel to meet with mechanical and electrical subcontractors and mechanical engineer as specified in Sections 221123, 233400, and 238100 to assure that all parties understand what interconnections are required.

**1.11 WARRANTY**

- A. Include services, materials and equipment necessary for successful operation of Control system for period of one year after Substantial Completion date.
- B. Adjustment, required testing, and repair of system includes computer equipment, transmission equipment and sensors, and control devices.
- C. On-line support services shall allow local DDC subcontractor to dial out over telephone lines or Internet to monitor and control facility's building automation system. This remote connection to facility shall be within 2 hours of time that problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends, and holidays. If problem cannot be resolved with on-line support services, DDC system manufacturer shall dispatch appropriate personnel to job site to resolve problem within 3 hours of time that problem is reported.
- D. At end of warranty period, Control system subcontractor shall re-check entire system operation, including calibration testing of sample number of components and performing necessary control adjustments for proper system operation. Such work shall be for minimum of 24 man-hours in conjunction with the Owner's technicians.

**1.12 SPARE PARTS**

- A. Controllers: Two unitary controllers and 2 VAV unit controllers. Deliver to the Owner at Substantial Completion.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Manufacturer: Tridium Niagara Framework version N4.13 (or most current) including Niagara Security and Niagara Analytics. No substitutions.

- B. Manufacturer's Representative: MacDonald Miller (Contact – Dan Freyling – 206.768.4056), or approved by Owner.

## 2.02 GENERAL

- A. The Integration Platform shall be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.
- B. The installed system shall provide secure strong password access to all features, functions and data contained in the overall BMS.

## 2.03 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing Open protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, shall be via Ethernet or IP.
- C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
- D. The supplied system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the Niagara Enterprise Supervisor VM hosted by the owner. See network diagram for details.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.
  - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
  - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote connected user interfaces.

## 2.04 SERVER HARDWARE

- A. Existing: The existing server is mounted in the server rack at the City of Federal Way City Hall Building. Server shall be provided with a keyboard and mouse. All Hardware and OS, VMM software will be provided by the Owner.

2.05 **SERVER SOFTWARE – NIAGARA 4 SUPERVISOR – N4S**

- A. The server software shall allow multiple Niagara-based JACE controllers, along with other IP-based controllers, to be networked together through the enterprise network. This software shall provide real-time graphical information to standard web-browser clients and provide server-level functions. These functions include centralized data logging/trending, alarming, tagging, archiving to external databases, alarming, dashboarding, system navigation, master scheduling, database management, and integration with other enterprise software applications through custom APIs where required. A comprehensive graphical engineering toolset for application development shall be provided (Niagara 4 Workbench).
- B. The Controls Subcontractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BMS server shall communicate using ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
- C. The intent of the thin-client architecture is to provide the operator(s) complete access to the BMS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Windows operating systems. All browsers shall be in compliance with Owner's IT standard.
- D. The BMS server software shall support at least the following server platforms (Windows 10, Server 2019). The BMS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
- E. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:
  - 1. Trending.
  - 2. Scheduling.
  - 3. Electrical demand limiting.
  - 4. Energy Aggregation and Analytics.
  - 5. Downloading Memory to field devices.
  - 6. Real time 'live' Graphic Programs.
  - 7. Tree Navigation.
  - 8. Parameter changes of properties.
  - 9. Set point adjustments.
  - 10. Alarm / event information.
  - 11. Configuration of operators.
  - 12. Execution of global commands.
  - 13. Add, delete, and modify graphics and displayed data.
- F. Software Components: All software shall be the most current version. All software components of the BMS system software shall be provided and installed as part of this project. BMS software components shall include:
  - 1. Server Software, Database and Web Browser Graphical User Interface.
  - 2. 5 Year Software Maintenance Agreement (SMA) license. Labor to implement not included.
  - 3. Embedded System Configuration Utilities for future modifications to the system and controllers.



4. Embedded Graphical Programming Tools.
  5. Embedded Direct Digital Control software.
  6. Embedded Application Software.
- G. BMS Server Database: The BmS server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 19c, 18c or IBM DB2. Owner IT will provide any non-Niagara DB licenses if required.
- H. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over secured Owner's Operational Technology Network.
  2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be TLS 1.2 or TLS 1.3 as directed by owner's Cyber Security department.
- I. Web Browser Graphical User Interface.
1. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.
  2. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.
  3. Navigation: Navigation through the GUI shall be accomplished by selecting the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
    - a. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.



- b. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.
  - c. Navigation: Navigation through the GUI shall be accomplished by selecting the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
4. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:
- a. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floorplans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
  - b. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web browser. User shall have ability to save custom dashboards.
  - c. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
  - d. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
  - e. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
  - f. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
  - g. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
  - h. Logic - Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
  - i. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

- J. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated where . gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:
1. Display Size: The GUI workstation software shall graphically display in a minimum of 1024 by 768 pixels 24-bit True Color.
  2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
  3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
  4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone using a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
  5. All graphics shall be compatible with any desktop, mobile device or tablet.
  6. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
    - a. Each piece of equipment monitored or controlled including each terminal unit.
    - b. Each building.
    - c. Each floor and zone controlled.
    - d. See System Integration Matrix for details.
- K. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.
1. Schedules: Schedules shall comply with the LonWorks and BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
    - a. Types of schedule shall be Normal, Holiday or Override.
    - b. A specific date.
    - c. A range of dates.
    - d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
    - e. Wildcard (example, allow combinations like second Tuesday of every month).
  2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.

3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
  4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
  5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
  6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.
- L. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
  2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
  3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
  4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
  5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
  6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.

7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BMS Server database.
  8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
  9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BMS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
    - a. Print: Alarm information shall be printed to the BMS server's PC or a networked printer.
    - b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
    - c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
    - d. Write Property: The write property reporting action updates a property value in a hardware module.
    - e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
    - f. Run External Program: The Run External Program reporting action launches specified program in response to an event.
    - g. Provide alarm recipients and escalation per direction from Owner.
- M. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
  2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the HEWS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
  3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
  4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
  5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.

6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
  7. Copy/Paste. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).
- N. Security Access: Systems that Security access from the web browser GUI to BMS server shall require a Login Name and Strong Password. Access to different areas of the BMS system shall be defined in terms of Role-Based Access Control privileges as specified:
1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of 'easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
    - a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
    - b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
    - c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.
  2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.
- O. Graphical Programming. Niagara 4 Workbench 4.13 or latest version at commissioning.

## 2.06 TAGGING

- A. The purpose of a data modeling standard is to provide a consistent, standardized methodology for naming and describing data points associated with the Integrated Automation Topology for this project. This includes the facility automation systems, equipment systems, energy metering systems, other smart devices including mobile assets, and associated descriptive information known as metadata.
1. Coordinate with the Owner for ideal tagging methodology.
  2. The Niagara Tagging standard shall be used for this project paired with a Building Location tagging Library. The building location tagging library shall include Compass Directional, which will be bi-directional (eg., NE, SW, NW, SE) and the Building Level (eg., 1st floor, 2nd floor, 3rd floor, etc.).
  3. Points List: Refer to Drawings for Points List.

## 2.07 SYSTEM NETWORK CONTROLLER (SNC)

- A. Provide JACE 9000 controllers designed to manage communications between the programmable equipment controllers (PEC) and application specific controllers (ASC) connected to its communications trunks, manage communications between itself and other system network controllers (SNC), and perform control and operating strategies for the system based on information from any controller connected to the BMS.
- B. The controllers shall be fully programmable.

- C. The controllers shall be capable of peer-to-peer communications with other SNCs.
- D. The communication protocols utilized for peer-to-peer communications between SNCs shall be Niagara 4 Fox, BACnet TCP/IP and SNMP.
- E. The SNC shall be provided with a device count capacity license that supports all devices to be integrated into the DDC with an additional 10% capacity for future devices.
- F. The SNC shall be licensed with the protocol drivers (client and server) needed for communications with project specific equipment. All SNCs shall be provided and licensed with drivers for BACnet MS/TP and BACnet/IP by default.
- G. The SNC shall be capable of executing application control programs to provide the following.
  - 1. Calendar functions.
  - 2. Scheduling.
  - 3. Trending.
  - 4. Alarm monitoring and routing.
  - 5. Time synchronization.
  - 6. Integration of LonWorks, BACnet, and MODBUS controller data.
  - 7. Network management functions for all SNC, PEC and ASC based devices.
- H. The SNC shall provide the following hardware features as a minimum.
  - 1. NXP iMX8M+ Quad Core CPU.
  - 2. 2 GB LPDDR4 RAM.
  - 3. 8 GB Onboard EMMC Storage.
  - 4. 8 GB Micro-SD Card (Back-Up Media).
  - 5. USB Type C Connector – Debug Port.
  - 6. Wi-Fi (Client or WAP)
    - a. Wi-Fi 5 (802.11ac).
    - b. 1x1 802.11 a/b/g/b/ac.
    - c. Configurable Radio (Off, WAP, or Client).
    - d. WPAPSK/WPA2PSK Supported.
  - 7. Two 10/100/1000 Mbps Ethernet ports.
  - 8. Two Isolated RS-485 ports with Biasing Switches.
  - 9. -20-60°C Ambient Operating Temperature.
  - 10. 24 VAC/DC Global Power Supply.
  - 11. Option cards or expansion modules for necessary communication ports/protocols.
- I. The SNC shall support standard Web browser access via the Intranet/Internet.
- J. The SNC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.
- K. The SNC shall be able to route any alarm condition to any defined user location whether connected to a local network or wide-area network.
  - 1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
    - a. Alarm.

- b. Return to normal.
  - c. To default.
2. Alarms shall be annunciated in any of the following manners as defined by the user:
  - a. Screen message text.
  - b. Email of complete alarm message to multiple recipients.
  - c. Graphics with flashing alarm object(s).
3. The following shall be recorded by the SNC for each alarm (at a minimum):
  - a. Time and date.
  - b. Equipment (air handler #, access way, etc.).
  - c. Acknowledge time, date, and user who issued acknowledgement.
- L. Programming software and all controller "Setup Wizards" shall be embedded into the SNC.

#### 2.08 PROGRAMMABLE EQUIPMENT CONTROLLER (PEC)

- A. Provide native BACnet application controllers for each piece of HVAC equipment or system that adequately supports all control devices required for unit or system operation. PECs shall interface to SNC using BACnet MS/TP, BACnet IP, or BACnet TCP/IP protocols. Controllers shall include input, output, and self-contained logic programs as required for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on existing Tridium N4 Server. PECs shall be BTL listed.
- B. PECs shall be application programmable and maintain their certifications. Control sequences programmed into the PEC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
- C. PECs shall provide LED indication of communication and controller performance without cover removal.
- D. PECs shall support the following.
  1. Dry contact digital inputs.
  2. Pulse inputs.
  3. Analog inputs w/ 10-bit resolution (configurable as 0-5VDC, 4-20mA, or thermistor).
  4. Analog outputs (configurable as 0-10V or 0-20mA).
  5. Digital / binary 24VAC triac outputs.
  6. One integral 24VDC, 100mA power supply for auxiliary devices.
  7. Communications for intelligent space sensor.
  8. Spare points: Provide a minimum of 4 spare points for each Input/Output point type (not including pulse inputs).
- E. PECs may utilize expansion modules to support additional I/O requirements as needed for larger applications (e.g. central plants).
- F. PECs shall support at minimum the following control techniques.
  1. General-purpose control loops that can incorporate demand control and setpoint reset strategies.
  2. General-purpose, non-linear control loops.
  3. Start/stop Loops.



4. If/Then/Else logic loops.
  5. Math Function loops (MIN, MAX, AVG, SUM, SUB, SQRT, MUL, DIV).
- G. PECs used for central plant applications and air handling units with more than 11 inputs shall additionally include the following features.
1. Hand-Off-Auto (HOA) switches with status indicator lights for all outputs.
  2. Real time clock with battery backup and time-based scheduling capabilities.
  3. Onboard scheduling, logging, and alarm generation that will continue to function upon loss of communications with the SNC.

#### 2.09 APPLICATION SPECIFIC CONTROLLER (ASC)

- A. Provide native BACnet application controllers for each piece of unitary HVAC equipment that adequately supports control devices. All controllers shall interface to SNC through LAN using BACnet MS/TP or BACnet IP protocol. Controllers shall include input, output, and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on existing Tridium N4 Server. ASCs shall be BTL listed.
- B. ASCs shall be application programmable and maintain their certifications. Control sequences programmed into the ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
- C. The ASCs shall provide LED indication of communication and controller performance without cover removal.
- D. All ASCs shall be selected to provide sufficient Inputs/Outputs for each application. ASCs shall support the following.
1. Dry contact digital inputs.
  2. Analog inputs w/ 10-bit resolution (configurable as 0-5VDC, 4-20mA, or thermistor)
  3. Analog outputs (configurable as 0-10V or 0-20mA) if required for the application.
  4. Digital / binary 24VAC triac outputs.
  5. Communications for intelligent space sensor.
- E. ASCs shall support general-purpose control loops that can incorporate demand control and setpoint reset strategies.
- F. ASCs serving Variable Air Volume (VAV) Terminal Units shall have onboard airflow sensors for room-level pressure-independent VAV control. Flow sensors shall be pre-calibrated at the factory with calibration data stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in unit type and installation.

#### 2.10 DDC LAN COMMUNICATION SYSTEM

- A. Design of DDC LAN communication system shall support networking of servers, SNCs, PECs, ASCs, etc.
- B. Design of DDC LAN communication system shall include, but not be limited to, communication wiring, raceways, network connections, and network routing hardware (e.g. switches and routers) necessary to provide a complete operating DDC communication system.



- C. Access to system data shall not be restricted by hardware configuration of DDC communication system. Hardware configuration of DDC communication system shall be transparent to user when accessing data or developing control programs.
- D. SNCs, PECs, and ASCs shall connect to DDC communication system without use of an interposing device.
- E. Any break in communication with SNCs, PECs, and ASCs, shall result in an alarm notification at the server.
- F. DDC system software applications shall run as a service to allow communication between SNCs, PECs, and ASCs without need for user log in. Closing application or logging off shall not prevent processing of alarms, network status, panel failures, and trend information.
- G. Operator interfaces shall have ability to access all point status and application report data and execute control functions for all devices. Access to data shall be based upon logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to network data.
- H. DDC LAN communication system shall provide the following minimum performance.
  - 1. High-speed data transfer rates for alarm reporting, report generation from multiple controllers and upload/download efficiency between network devices. System performance shall ensure that an alarm occurring at any SNC is displayed at all SNCs within 15 seconds.
  - 2. Message and alarm buffering to prevent information from being lost.
  - 3. Error detection, correction, and re-transmission to guarantee data integrity.
  - 4. Synchronization of real-time clocks between SNCs, including automatic daylight savings time corrections.
- I. DDC LAN communication system shall provide system wide wild card point search, command, and access direct from any SNC on network.

#### 2.11 SENSING DEVICES

- A. Temperature Sensors:
  - 1. General:
    - a. Description: Thermistor type for temperature sensing applications below 200 F, 10K Ohms.
    - b. Accuracy: Minimum plus or minus 0.7 F over a range of 32 F to 150 F unless otherwise specified.
    - c. Element and Leads: Encapsulated. Bead thermistors not acceptable.
    - d. A/D Conversion Resolution Error: Less than or equal to 1 percent.
    - e. Total Error for Thermistor Circuit: Not to exceed 0.5 F, which includes sensor error and DDC controller A/D conversion resolution error.
    - f. Cable: 18 gauge twisted or shielded.
  - 2. Room Temperature Sensor:
    - a. Accuracy: Plus or minus 1 F.
    - b. Integral push-button for digital input to controller for system override.
    - c. Setpoint adjustment with preset limits.

- d. Analog input to DDC controller.
  - e. Digital thermometer.
  - f. Cover color off-white or beige as selected by the A/E.
  - g. Flush flat panel for installations in corridors, toilet rooms, locker rooms, and other high impact areas and where indicated on the Drawings.
3. Duct Temperature Sensor:
- a. Accuracy: Plus or minus 1 F.
  - b. Duct Averaging Type: Continuous averaging type for ductwork applications, 2 foot length for each 4 square feet of ductwork cross-sectional area with 6 foot minimum length.
  - c. Probe Type: One foot length minimum for ducts 3 foot square and less. Spot sensor if cross-sectional area is less than 18 square inch and for VAV and FTU discharge temperature.
4. Outside Air Temperature Sensor:
- a. Accuracy: Plus or minus 3 F.
  - b. Stainless steel encased, mounted with watertight fittings.
  - c. Shield consisting of a 0.080 inch minimum sheet aluminum enclosure to protect sensing element from snow, ice, and rain. Shield designed to allow free flow of ambient air across sensing element.
- B. Immersion Temperature Sensor:
- 1. Accuracy: Plus or minus 1 F.
  - 2. Insertion type, stainless steel encased, matched with thermal well installed.
  - 3. Thermal wells Monel, brass, or copper for use in copper water lines, and Type 316 stainless steel for other applications.
  - 4. Thermal wells 3 inch long for pipe sizes 4 inch and smaller and 6 inch long for pipe sizes 6 inch and larger.
  - 5. Provide heat-sensitive transfer agent between exterior sensor surface and interior well surface.
- C. Carbon Dioxide (CO<sub>2</sub>) Sensors:
- 1. Designed for demand controlled ventilation to measure atmospheric and room CO<sub>2</sub> levels and transmit signals to DDC system.
  - 2. 5-year self-calibration.
  - 3. Sensing range 0 to 2000 ppm.
  - 4. Accuracy plus or minus 30 ppm plus 2 percent of reading, including nonlinearity and calibration uncertainty.
  - 5. Non-linearity less than plus or minus 1 percent of full scale.
  - 6. Long term stability less than 5 percent of full scale over 5 years.
  - 7. 1 minute response time.
  - 8. 4 to 20 mA or 0 to 10 V DC output signal.
  - 9. Wall mounted or duct mounted as indicated on the Drawings.
  - 10. Include calibration kit.
  - 11. Manufacturers: Vaisala CARBOCAP® Transmitter Series GM20, SenseAir® Model aSENSE-k Series, Telaire, AirTest™ Technologies Inc., Veris Industries or approved.

D. Transmitters:

1. General:

- a. Output 4 to 20 mA or 2 to 10 V AC, linearly scaled to temperature, pressure, or flow range being sensed.
- b. Total error not to exceed 0.1 percent of 20 mA (0.02 mA) at any point across 4 to 20 mA span.
- c. Supply voltage 24 V AC or 24 V DC.
- d. Noninteractive offset and span adjustments.
- e. Spans and Ranges - Temperature:
  - 1) 50 F Span: Room, chilled water, cooling coil discharge air, and return air sensors.
  - 2) 100 F Span: Outside air, domestic hot water, heating coil discharge air, and mixed air sensors.
- f. Spans and Ranges - Pressure:
  - 1) Minus 0.1 to Plus 0.1 inch of Water Differential Range: Room static pressure control.
  - 2) Minus 1.0 to Plus 1.0 inch of Water Differential Range: Duct, filter, or fan static pressure.

2. Temperature Transmitters:

- a. Consist of combination temperature sensors and transmitters. Match each transmitter to its temperature sensor.
- b. Factory calibrated and sealed.

E. Differential Air Pressure Transmitter:

1. Device with integral pressure transducer and transmitter. Include offset and span adjustments.
2. Sensing element either capsule, diaphragm, bellows, Bourden tube, or solid state.
3. Rated for 150 percent of working pressure.
4. Accuracy plus or minus 1 percent corresponding to pressure span.
5. Linearity 0.1 percent.
6. Output 4 to 20 mA signal proportional to pressure span.
7. Supply voltage 24 V AC or 24 V DC.

F. Differential Air Pressure Switches:

1. Diaphragm or bourden tube sensor.
2. Rated for 150 percent of working pressure.
3. Repetitive accuracy plus or minus 2 percent of operating range.
4. Switch actuation adjustable over operating pressure range in accordance with NEMA ICS 1.
5. Snap action Form C contact rated for application.

G. Differential Static Pressure Switches:

1. Diaphragm type differential static pressure switch for binary (two-position) operation.
2. Rated for pressure surges to 150 percent of peak application pressure.

3. Repetitive accuracy plus or minus 1 percent.
  4. Range selected for operating pressure trip point of approximately midpoint of pressure switch adjustable range.
  5. Snap action Form C contact and switch rated for application, wired for normally open or normally closed operation.
  6. Adjustable trip setpoint.
- H. Low Temperature Protection Switches (Freezestat):
1. Capillary type electric temperature actuated switch.
  2. Special purpose insertion thermostats with flexible elements minimum 20 feet in length for coil face areas up to 40 square feet. Include additional or longer elements for larger coils at rate of 1 foot length of element for each additional 1.5 square feet of coil.
  3. Factory made radius turning guide for changes in direction that element makes in serpentine configuration.
  4. Freezing condition at 12 inch increments along sensing element activates thermostatic switch.
  5. Adjustable setpoint.
  6. Automatic reset after activation.
  7. Switch contacts rated for motor starter circuit voltage being interrupted.
  8. Switch equipped with auxiliary set of contacts for input of switch status to DDC system.
- I. Timer Switches: Wall mounted, manual operation, 0-2 hour adjustable setting. Include stainless steel cover and engraved nameplate.
- J. On/Off Switches: Wall mounted, single pole type with illuminated switch to indicate that controlled item is operating. Include stainless steel cover and nameplate.
- K. Three-Position Switches: Wall mounted, center off position, number of poles and throws to suit application. Include stainless steel cover with engraved switch positions. Include nameplate.
- L. Current Transducers (Current Sensing Relays):
1. Designed to monitor amperage of motors.
  2. Range for normal amperage to be above 50 percent of range.
  3. Accuracy 1 percent of full scale.
  4. Digital on/off output signal.
  5. Indicate whether normally open or normally closed.
  6. Trip-point approximately midpoint of switch adjustable range. Adjust relay switch point so that relay responds to motor operation under load as an "on" state and so that relay responds to unloaded running motor as an "off" state. Motor with broken belt is considered an unloaded motor.
  7. Limit off-state leakage to 2 mA or less.

## 2.12 CONTROLLED HARDWARE DEVICES

- A. Motorized Dampers, Square and Rectangular, Low Leakage:
1. Description: Airfoil blade, AMCA Class 1A leakage rated type.

2. Performance: Maximum allowable leakage of 3 cfm per square foot of damper face area at 1 inch w.g. pressure difference as tested in accordance with AMCA Standard 500-D and certified for air performance and air leakage performance per AMCA 511.
  3. Construction:
    - a. Blades: Six inch maximum blade width, airfoil shape, galvanized steel.
    - b. Frame: Galvanized steel hat channel with corner braces.
    - c. Bearings: Stainless steel, permanently lubricated.
    - d. Seals: Extruded vinyl or stainless steel on blade edge suitable for operating temperature range of minus 72 F to 275 F, flexible metal compression type at jamb.
    - e. Linkage Hardware: Concealed in frame, aluminum or corrosion resistant zinc and nickel plated steel construction linkage assembly and mountings for 1 damper actuator per each 20 square feet of damper face area.
    - f. Axles: Plated steel, hexagonal.
  4. Blade Type: Opposed blade for modulating control and parallel blade for two-position control. Parallel blade for air handling unit mixing dampers as specified in Section 233400.
  5. Manufacturers: Ruskin Company CD60, TAMCO, Greenheck, NCA Manufacturing, Inc., American Warming and Ventilating Co., Nailor Industries Inc., or approved.
- B. Electric Actuators:
1. Description: Direct drive (direct shaft mounted) electric actuators for damper control applications.
  2. Positive means of preventing slippage of actuated device shaft.
  3. UL listed and labeled with NEMA 2 enclosure.
  4. When operated at rated voltage, capable of delivering torque required for continuous uniform movement of valve or damper.
  5. Include end switch or built-in electronic control feature to limit travel and to withstand continuous stalling without damage.
  6. Proper function with range of 85 to 110 percent of line voltage.
  7. Fiber or reinforced nylon gears may be used for torques less than 16 inch pounds.
  8. Mechanical spring return for outside air dampers, and exhaust air dampers. Other applications as indicated on the Drawings.
  9. Proportioning operators capable of stopping at points in cycle and starting in either direction from any point.
  10. Normally open and normally closed as indicated on the Drawings to result in valve or damper position under failure of control power to device.
  11. Electric actuator auxiliary switches to indicate open/closed status. Calibrate with remote monitoring/control function.
  12. For modulating damper actuators, include position feedback via 2 to 10 V DC analog output feedback signal suitable for wiring to analog input point in DDC system. "Modulating" is defined as analog control. Floating point actuator not acceptable.
  13. For multiple actuators controlled from a single output signal, include cascading signal relationship via "master-slave" wiring to ensure damper assembly is responding to input signal.
  14. Manufacturers: Belimo Aircontrols (USA), Inc. No substitutions.

### 2.13 FIRE ALARM DEVICES

- A. Description: Complete functionality of fire alarm devices is included in this section. Duct smoke detectors as required by IMC. UL listed and labeled and FM approved detectors for duct installation. Coordinate electrical/mechanical interface with Division 28.
- B. Duct Smoke Detectors: Furnished under Division 28 work and installed under Section 233100. Coordinate fire alarm system shutdown of HVAC systems with Division 28.

### 2.14 AUXILIARY COMPONENTS

- A. Control Panels:
  - 1. NEMA 1, hinged door with nameplate, key locking with single key to operate all locks, logically assembled at one or more locations.
  - 2. Include terminal strips with 25 percent spare capacity for external connections.
  - 3. Push buttons, maintained contact type, spring return. Contacts rated minimum 10 Amps at 120 V.
  - 4. Record control drawings secured to inside of panel door, enclosed in plastic jackets, for each system at each panel.
  - 5. Laminated engraved plastic labels at interior control devices on panel (not on the device) for identification in conjunction with record control drawings. Include device number, its normal operation, and setpoint (example, "TC-7, DIRECT-ACTING, 60 F, RESET"). Include reset schedules for devices with reset.
  - 6. Coordinate electrical power supply with work of Division 28. Include single 120 V, 15 Amp service to each panel.
- B. Nameplates and Tags:
  - 1. Laminated engraved plastic or brass nameplates for equipment and devices.
  - 2. Identify equipment name by function, such as "COLD DECK TEMPERATURE", and point identification number as shown on record control drawings as plain text device description, such as "SPS-18 STATIC PRESSURE SENSOR".
  - 3. Laminated plastic 1/8 inch thick, black and white letters.
  - 4. Minimum size 1 inch by 3 inch, with minimum of 3/8 inch high engraved block lettering.
- C. Smoke Damper Indication: Furnish local remote indication of blade damper position by means of recessed mounted junction box with engraved nameplate having "RED" (for closed) and "GREEN" (for open) LEDs.

### 2.15 SURGE PROTECTION FOR DDC SYSTEMS

- A. Description: Surge and transient protection devices to DDC controllers. Protection devices integral to DDC system components are acceptable.
- B. Power Line Surge Protection: Do not use fuses for surge protection. Include surge suppresser on incoming AC power. Comply with UL 1449 and IEEE. Clamping voltage ratings below the following levels:
  - 1. Normal Mode (Line to Neutral): 350 Vs.
  - 2. Common Mode (Line to Ground): 350 Vs.

- C. Communication Line Surge Protection:
  - 1. Metal oxide varistor (MOV) protection rated for application at equipment.
  - 2. At each building entry and exit point, protect wire communications trunk wiring with transient surge protection devices for minimal protection.
  - 3. Transient surge protection is not necessary if communication trunk external to building is fiber optic.
  
- D. Communications Links Overvoltage Protection:
  - 1. Protect communications equipment such as network devices, line drivers, and repeaters against overvoltage.
  - 2. Include overvoltage protection for cables and conductors which serve as communications links for voltages up to 480 V AC RMS, 60 Hz. Instrument fuses, fusible resistors, or carbon surge arresters are acceptable for this application.
  
- E. Sensor and Control Wiring Surge Protection:
  - 1. Protect digital and analog inputs and outputs against surges and transients induced on control and sensor wiring.
  - 2. Optical isolation, metal oxide varistors (MOVs), or silicon avalanche devices.

## 2.16 ELECTRIC POWER AND DISTRIBUTION

- A. Source: 120 V or less, 60 Hz, two-pole, 3 wire with ground. Devices UL listed and labeled or FM approved. Coordinate with Division 26.
  
- B. Transformers:
  - 1. Limited energy type step down type with capacity to operate simultaneously connected apparatus with 25 percent overload for 1 hour.
  - 2. Comply with UL 506.
  - 3. Supply AC electrical power to DDC controllers specified in this Section on highest level LAN from dedicated circuit breakers.
  - 4. Coordinate with Division 26.

## 2.17 CONTROL WIRING

- A. General:
  - 1. Include wire and cable not shown on electrical drawings for complete and operable control system including wiring to transformer primaries.
  - 2. Conform to NEC and Division 26 requirements.
  - 3. Provide circuits operating at more than 100 V in accordance with Division 26.
  - 4. Include transformers to supply power for low voltage circuits.
  - 5. Use multiconductor cable for concealed accessible locations only.
  - 6. Include circuit and wiring protection as required by NFPA 70.
  - 7. Provide printed labels at controllers identifying connected devices with name and number. Device numbers only not acceptable.
  
- B. Control Wiring:
  - 1. Copper No. 18 AWG minimum with 300 V insulation, stranded.

2. Wire used for analog functions twisted and shielded, 2, 3, or 4 wire to match analog function hardware.
  3. Copper No. 16 AWG within control panels for binary outputs and pilot relay.
  4. Multi-conductor wire with outer PVC jacket.
  5. Insulation rating for control wiring installed in control panels and other enclosures with power circuit conductors no less than that for power circuit conductors.
- C. Sensor Wiring:
1. Copper No. 20 AWG minimum, stranded, twisted and shielded, 2, 3, or 4 wire to match analog function hardware, with No. 20 AWG drain wire. Exception: Direct connect RTD wiring single No. 18 AWG minimum twisted pair, 100 percent shielded with No. 20 AWG drain wire.
  2. Multi-conductor wire with outer PVC jacket.
- D. Aluminum Wiring: Not acceptable.
- E. Raceway:
1. Interior dry locations: Electrical metallic tubing (EMT), hot-dipped galvanized, with insulated throat galvanized steel compression fittings. Minimum 3/4 inch conduit size.
  2. Exterior or wet locations: Liquid-tight flexible metal galvanized with PVC weatherproof cover with insulated throat, galvanized steel fittings. Minimum 3/4 inch conduit size.
  3. Comply with additional requirements in Division 26.
- F. Surface Raceway: For sensor and control wiring in existing finished spaces where "fishing" in walls is not possible. Wiremold, Panduit, or approved.
- G. Line Voltage Wiring: Wiring for 120 V single conductor, copper No. 14 AWG minimum, rated for 600 V service.
- H. Plenum Cable: UL listed and labeled for plenum use.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.



**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 WORK PRIOR TO INSTALLATION**

- A. General: Conduct pre-installation conference prior to control system subcontractor installing any materials required by this section. Conference shall occur after submittals have been satisfactorily reviewed by the A/E and approximately 14 days prior to proposed system installation date. Purpose of this conference is to review Control system subcontractor installation methods, materials, schedule, safety, coordination with other trades, and related construction/design issues to allow for efficient and proper construction. The A/E and Owner will highlight various items of concern, typical problems encountered on similar projects, coordination issues, and related items.
- B. Attendance: Pre-installation conference shall be attended by control system subcontractor doing the Work of this section, other mechanical and electrical trades as appropriate to proper coordination of work of this section, the Owner's representatives (at their option), and the A/E.
- C. Control System Verification: Become familiar with details of the Work in field. Advise the A/E of any discrepancy before performing the Work.
- D. Coordination: Control system subcontractor shall notify the A/E of system subcontractor readiness to hold pre-installation conference at least 14 days prior to proposed meeting time.

**3.05 CONTROL SYSTEM, GENERAL**

- A. Description: Install devices and hardware required to ensure complete and operating system in accordance with sequences of operation.
- B. Quality: Install components and wiring in neat and workmanlike manner, using trained mechanics, conforming to applicable codes. Perform installation under supervision of competent technicians regularly employed in installation of control systems.
- C. Control Panels: In general, mount 4' - 6" above floor, panel top at 6' - 6" above floor maximum, with 3 feet minimum clear access space in front of panels. Indicate locations on the Shop Drawings.

**3.06 DIRECT DIGITAL CONTROL SYSTEM**

- A. Control System Configuration:
  - 1. Connect each major mechanical system to single trunk to permit intercommunication between DDC controllers and associated DDC controllers on particular system.
  - 2. Do not divide control of single mechanical system between two or more DDC controllers when a larger single controller can meet point requirements. Single controller shall manage control functions for single mechanical system. Managing more than one mechanical system with single DDC controller is acceptable. If a single mechanical system cannot be controlled by a single controller, multiple controllers are acceptable.

- B. Control Panels:
  - 1. Locate and install DDC controllers in control panels for accessibility.
  - 2. Include main power switch for each highest level LAN DDC controller within control panel.
  - 3. Multiplexing of points not acceptable.
- C. DDC Input/Output Summary:
  - 1. Points List: Refer to Drawings for Points List.

### 3.07 INSTRUMENTATION AND CONTROLS

- A. Installation, General:
  - 1. Install devices to be easily accessible.
  - 2. Install to protect instruments, switches, transmitters, and other devices from vibration and high temperatures.
  - 3. Panel mount devices unless devices are installed directly on duct or piping.
  - 4. In no case shall sensors designed for one application be installed for another application.
- B. Relays and Contactors: Install interposing relays and contactors required to accomplish sequences of operation.
- C. Temperature Sensor Locations: General locations indicated on the Drawings. Indicate actual locations on the Shop Drawings. Relocate if thermostat and temperature sensor performance is unsatisfactory at no additional cost to the Owner.
- D. Room Thermostats Temperature Sensors:
  - 1. Install on interior walls to sense average room temperature conditions.
  - 2. Avoid locations which may be covered by office furniture.
  - 3. Do not mount on exterior walls when other locations are available. If located on exterior walls, install with insulated base.
  - 4. Locate devices at same elevation.
  - 5. Comply with requirements of Americans with Disabilities Act (ADA) as applicable. Install devices with maximum top elevation above finished floor in accordance with the following:
    - a. ADA Applications, Forward Reach Access Only (No Obstructions): Top elevation 48 inch above finished floor.
    - b. ADA Applications, Side Reach Access (Parallel Approach Space Available): Top elevation 48 inch above finished floor.
    - c. Non-ADA Applications: Top elevation 60 inch above finished floor unless indicated otherwise in the Contract Documents.
- E. Duct Temperature Sensors:
  - 1. Install in ductwork with self-tapping sheet metal screws. Install metal rods and brackets to support averaging element. Element may be supported with existing supports where available.

2. Install in ductwork in general locations as indicated on the Drawings. Select specific location within duct to accurately sense appropriate air temperatures. Do not locate in dead air spaces or positions obstructed by ducts or equipment.
  3. Install gaskets between sensor housing and duct wall. Seal duct and insulation penetrations.
  4. Install duct averaging sensor between 2 rigid supports in serpentine position to sense average conditions. Thermally isolate temperature sensing elements from supports.
  5. Install continuous averaging type for ductwork applications, 2 foot length for each 4 square feet of ductwork cross-sectional area with 5 foot minimum length.
  6. Install single point type, one foot length minimum for ducts 3 foot square and less. Spot sensor if cross-sectional area is less than 18 square inch.
- F. Outside Air Temperature Sensors:
1. Install outside on north side of building away from exhaust hoods, air intakes, and other areas that may affect temperature readings.
  2. Install sunshields to protect thermostat from direct sunlight.
- G. Low Temperature Protection Switches (Freezestat):
1. For each 40 square feet of coil-face area, install temperature switches to sense temperature at locations indicated on the Drawings. Install element in serpentine pattern.
  2. Hard wire freezestat through transformer that serves outside air damper. Relying on controls logic to close outside air damper upon event not acceptable.
- H. Pipe Temperature Sensors:
1. Install so that probe can be removed for field calibration and testing.
  2. Establish location of thermowells for sensors measuring temperatures in liquid applications or pressure vessels.
  3. Locate wells to sense continuous flow conditions.
  4. Do not install wells using extension couplings.
  5. Where piping diameters are smaller than length of wells, locate wells in piping at elbows to effect proper flow across entire area of well.
  6. Wells not to restrict flow area to less than 70 percent of pipe area.
  7. Apply thermal transmission material within well and install sealing nuts to contain thermal transmission material.
  8. Coordinate well placement, size, and configuration with work of Section 232113.
- I. Pressure Sensors and Switches:
1. Install in such manner that probe can be easily removed for field calibration and testing.
  2. Establish location of thermowells for sensors measuring temperatures in liquid applications or pressure vessels.
  3. Locate wells to sense continuous flow conditions.
  4. Where piping diameters are smaller than length of wells, locate wells in piping at elbows to effect proper flow across entire area of well.
  5. Wells not to restrict flow area to less than 70 percent of pipe area.
  6. Apply thermal transmission material within well and install sealing nuts to contain thermal transmission material.

7. Coordinate well placement, size, and configuration with work of Sections 232113 and 232113.
  8. Install pressure sensing tips in locations to sense appropriate pressure conditions. Install multiple pressure sensors as indicated on the Drawings or as required by the sequences of operation.
  9. Install duct static pressure tip approximately 2/3 distance from supply fan to end of duct with greatest pressure drop.
  10. For pump proof differential pressure switches, install low pressure sensor at pump suction and high pressure sensor at pump discharge.
  11. For steam pressure sensing, install pig tail, snubbers, and isolation valves on steam pressure sensing applications.
  12. For pumps controlled by variable frequency drives, install pressure sensors in piping mains as indicated on the Drawings.
- J. Motorized Dampers and Actuators:
1. Install minimum of 1 actuator for each damper.
  2. Arrange multi-section dampers so that each damper section operates individually with 1 actuator for each section.
  3. For dampers installed in ducts, do not install actuators in air stream.
  4. Install actuator on control shaft with positive locking mechanism.
- K. Duct Smoke Detectors: Coordinate installation of duct smoke detectors with Section 233100. Install at locations indicated on the Drawings. Install in return air ducts in accordance with NFPA 90A, except as otherwise indicated on the Drawings. Provide wiring to fan motor starters. Coordinate fire alarm system signal wiring with Division 28.
- L. Nameplates, Tags, and Laminated Shop Drawings:
1. Nameplates and Tags:
    - a. Install at field mounted equipment and devices, engraved with legend, unique identifier, or equipment name to correspond to designations on record control drawings.
    - b. Install on outside face of control panel doors.
    - c. Permanently attach with rivets or screws.
  2. Laminated Shop Drawings:
    - a. Prior to date of Substantial Completion, provide Shop Drawings, including control wiring diagrams, ladder diagrams, logic diagrams, flow charts, and similar items, in clear laminated plastic, 11 by 17 inch size.
    - b. Prepare full set of Shop Drawings and deliver to the Owner at central operator workstation.
    - c. Install drawings specific to a control panel within that control panel.

### 3.08 CONTROL WIRING

- A. General:
1. Comply with NEC requirements.
  2. Label each line voltage power supply with identification of feeder panel and breaker.

- B. Conduit and Wireways:
1. Install offsets and fittings necessary to accomplish installation of control system.
  2. Seal conduit with glass fiber where conduits leave heated area and enter unheated area
  3. Install UL-approved expansion and/or seismic fittings complete with grounding jumpers where conduits cross building expansion joints.
  4. Install bends or offsets in conduit adjacent to building expansion joints where conduit is installed above suspended ceilings.
  5. Alter conduit routing to avoid structural obstructions and minimize cross-overs.
  6. Allow minimum 6 inch of clearance at flues, heating water pipes, and heat sources.
- C. Wiring Raceway Requirements:
1. Install wiring in electrical metallic tubing (EMT) above inaccessible ceilings, concealed in walls and exposed non-mechanical room locations.
  2. Install wiring in electrical metallic tubing (EMT) in mechanical rooms.
  3. Conduit shall continue to within 12 inch of sensing and controlled hardware devices.
- D. Wiring Above Accessible Ceilings:
1. Regardless as to whether ceiling space is used as return air plenum, use plenum cable. This includes exposed wiring, wiring in cable trays, and wiring between conduit terminations and sensors and controlled devices.
  2. Install plenum cable at least 12 inch above ceiling tiles. Do not lay on top of ceiling tiles. Route plenum cable in a straight line supported by cable rings on 4 foot maximum centers and attached to building walls or supported by building structure or from cable tray provided under Division 27.
- E. Wiring within Control Panels: Arrange neatly in grouped horizontal and vertical directions, secured or under removable covers. Rewire non-conforming work as directed by the A/E. Protect exposed wiring from abuse and damage.
- F. Wire Terminations: Make bare to screw terminals specifically designed for bare stranded wire connections, or with self-insulated spade lugs where connected to screw type terminals not specifically designed for bare stranded wire connection.
- G. Splicing:
1. Minimize and perform only in accessible outlet, junction, or cabinet boxes that are included on the Drawings.
  2. When splicing is necessary, match insulation colors and mechanically secured conductors to each other so that no stress is applied to the splice.
- H. Wire Runs: Parallel or perpendicular to walls, pipes and sides of openings. Use right angle turns. Do not block passageways for access and servicing. Do not install control wiring in power circuit raceways. Do not use motor starters and disconnect switches as junction boxes. Install additional junction boxes.
- I. Fill: No conduit shall be filled such that maximum bundled cross sectional dimension exceeds 65 percent of conduit inside diameter. No raceway filled to more than 40 percent, except that maximum fill for surface raceway shall be 20 percent.

- J. Wire Length: Wire run or circuit no longer than 80 percent of maximum allowable length or power consumption for wire size and application. Output circuit not to exceed 80 percent of maximum load capacity specified by manufacturer.
- K. Identification: Conduits entering and leaving terminal cabinets and junction boxes identified in logical and consecutive manner. Use same number only once. Identify conductors with typed or machine lettered labels, Brady or approved. Tag numbers agree with wire numbers assigned on wiring diagrams and installation drawings. Number wires at each connection, termination, and junction box.
- L. Grounding: Ground controllers and cabinets to a good earth ground. Ground controller to ground in accordance with requirements in Division 26. Grounding of green AC ground wire at electrical circuit breaker panel alone, not acceptable. Run metal conduit from controller panels to adequate building grounds. Ground sensor drain wire shields at controller end.
- M. Electric Power for Controls:
1. Coordinate electrical power source required for work of this section with Division 26.
  2. Where not shown on electrical drawings, provide power wiring from electrical panel circuit breakers to controls system panels and devices requiring line voltage power. Provide limited energy transformers. Comply with NEC. Provide a disconnect on primary side of transformer and a resettable, fused cut-out on the secondary side of transformer.
  3. Do not connect control wiring to receptacle or lighting circuits.
  4. Transformers and line voltage controllers used to control a specific piece of equipment may be fed from power leads to that specific piece of equipment.
  5. Where emergency power is included in the work or exists in building, extend electrical power source for control from that emergency power system.
- N. Surge Protection for DDC System: Install surge protection no more than 3 feet from where communication cable enters building.
- O. Devices Specified in Other Divisions and for Existing Installations: Provide connections between control system components and sensor and control and alarm devices which require connections to controls system. Coordinate specific requirements with device or unit manufacturer.
- P. Low Voltage Wiring: Comply with requirements in Section 230513. Unless otherwise indicated on the Drawings, other Division 22 and 23 sections, or in Division 26, provide low voltage wiring for work of Divisions 22 and 23, including but not limited to:
1. Duct smoke detectors to associated fan motor starters.
  2. Temperature and flow control wiring.
  3. Domestic water heater field wiring.
  4. Moisture switch for drain pans for air conditioning units.
  5. Heat recovery unit control components field wiring.
  6. Packaged HVAC equipment field wiring.
  7. Domestic water pumping package field wiring.
- Q. Line Voltage Wiring: Comply with requirements in Section 230513. Unless otherwise indicated on the Drawings or in Division 26, provide line voltage wiring from electrical panel circuit breakers to control panels and devices including but not limited to:
1. Control panels.

2. Domestic water heater field wiring.
3. Smoke damper indication.
4. Heat recovery unit control components field wiring.
5. Packaged HVAC equipment field wiring.
6. Domestic water pumping package field wiring.

### 3.09 SEQUENCES OF OPERATION

- A. Description: Refer to the Drawings for sequences of operation.

### 3.10 CLEAN-UP

- A. Description:

1. Promptly remove waste material and rubbish as it accumulates.
2. At completion of the Work, clean dirt and construction debris, such as paint, plaster, glue, cement, mastic, tar, paper, tape, and dirt from the installation.
3. In finished areas to be occupied, keep equipment covered during construction. Where this is not practical, clean and refinish item to new condition.

### 3.11 FIELD TESTING AND VERIFICATION

- A. Field Tests: Calibrate field equipment and devices and verify equipment and system operation before placing automatic temperature control system on-line.

- B. Include the Following Tests:

1. Preliminary: Observe HVAC system in its shutdown condition. Check motorized dampers and control valves for proper normal positions.
2. Check each input device for proper calibration and operation. For each sensor, record readings at sensor and DDC system controller using traceable test equipment. Document each reading for test report.
3. Check operation of each output to verify correct operation. Command digital outputs on and off. Command analog outputs to minimum range, such as 4 mA, and maximum range, such as 20 mA. Measure and record commanded and actual output values. Document each command and result for test report.
4. With DDC system controller, apply control signal to each actuator and verify that actuator operates properly from its normal position to full range of stroke position. Record actual spring ranges and normal positions for modulating control valves and dampers. Include documentation in test report.
5. Demonstrate that programming is not lost after power failure and DDC system controllers automatically resume proper control after power failure.
6. Demonstrate that surge protection has been installed on incoming power to DDC system controllers and on communications lines.

- C. Software Operation Tests: Test compliance of application software for:

1. Demonstrate ability to upload and download control programs.
2. Demonstrate ability to edit control program offline.
3. Cause alarm conditions for each alarm and ensure that central operator workstation receives alarms.
4. Demonstrate ability of software to receive and save trend and status reports.

- D. Performance Verification Tests:
1. Conduct performance verification tests to demonstrate that DDC system maintains setpoints, control loops are tuned, and controllers are programmed for correct sequences of operation.
  2. Conduct performance verification test during one week of continuous control systems operation before final acceptance of work.
  3. Include the following:
    - a. Execution of Sequences of Operation:
      - 1) Demonstrate that mechanical system operates properly through complete sequences of operation (for example, seasonal, occupied/unoccupied, and warm-up cycles).
      - 2) Demonstrate that hardware interlocks and safeties operate properly.
      - 3) Graph trends to show sequences of operation are executed in correct order.
      - 4) Demonstrate proper system response for abnormal conditions by simulating these conditions.
      - 5) Demonstrate that system performs sequences of operation after power failure.
      - 6) Opposite Season Test: Repeat performance verification test during opposite season to first performance verification test. Test procedures of performance verification test shall be used for opposite season test.
    - b. DDC System Loop Stability and Accuracy: Graph trends of control loops to demonstrate control loop is stable and that setpoint is maintained. Control loop response shall respond to setpoint changes and stabilize in 1 minute. Control loop trend data shall be instantaneous and time between data points not greater than 1 minute.
    - c. Maximum allowable deviation of controlled values from their setpoints shall be as follows:
      - 1) Air Handling Unit Supply Air Temperature: Setpoint plus or minus 0.5 F.
      - 2) Room Temperature: Heating setpoint minus 0.5 F; cooling setpoint plus 0.5 F.
      - 3) Duct Static Pressure (For Fan Speed Control): Setpoint plus or minus 10 percent.
    - d. Test each point reporting to DDC system controllers and remote controllers for specified functions. Sign off test results by DDC system subcontractor and the A/E.
  4. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following:
    - a. Graphics navigation.
    - b. Trend data collection and presentation.
    - c. Alarm handling, acknowledgement, and routing.
    - d. Time schedule editing.



- e. Application parameter adjustment.
- f. Manual control.
- g. Report execution.
- h. Automatic backups.
- i. Web Client access.

E. Cyber Security:

- 1. Provide commissioning engineer for cyber security testing and set up using the Niagara Hardening Guide and under direction of the owner's Corporate Cyber Security Team.
- 2. Attend planning, engineering, and commissioning meetings as required by the owner's Cyber Team.
- 3. Provide Security Dashboard and Active Directory services.
- 4. Provide necessary port and configuration data to Owner's Cyber and IT teams.

F. Niagara Services and Features:

- 1. Provide Security Dashboard Service for each JACE and the Niagara Enterprise Supervisor.
- 2. Enable audit logs for all functions including system operation and programming and cyber security.
- 3. Set up Alarm Service recipients and escalation as directed by Owner.
- 4. Set up all roles and responsibilities as directed by Owner.
- 5. Graphics. Provide Graphics as described in System Integration Matrix and point lists. All graphics shall be designed using Niagara "ResponsivePane" to utilize a single graphic implementation to render on a variety devices and window or screen sizes (mobile, tablet desktop).
- 6. Set up schedules as directed by owner for each system and zone.
- 7. Set up provisioning service to provide daily backups of all JACEs to the N4S.
- 8. Each point will be trended at default rate of 15 minutes unless otherwise directed.

### 3.12 HVAC SYSTEMS TRAINING

- A. Comply with requirements in Section 230810 and the training requirements specified in this Section.
- B. Upon completion of Work, furnish services of a competent technician regularly employed by DDC manufacturer to provide a 2 hour training walk through of new DDC system with the City of Federal Way's lead DDC personnel for instruction of facility personnel in operation and maintenance of DDC system.
- C. Furnish a written test plan and training schedule for approval 15 days prior to instructing operating personnel including the following.
  - 1. Recommended training schedule for operator's workstation, standalone direct digital controllers, application specific digital controllers, and field components.
  - 2. Qualification of instructors.
  - 3. List of training materials, aids, etc.
  - 4. List of customer training schools offered by DDC manufacturer.

- D. Provide training materials necessary for a minimum of 6 facility personnel. Include the following:
1. Operations and maintenance manual.
  2. As-built control diagrams.
  3. Detailed description of system.
  4. Complete listing and graphical logic diagrams of software programs required to perform sequence of operation.
  5. Commands, operating and troubleshooting instructions, and routine maintenance procedures.
- E. Training I: Provide 8 hours of classroom training using training material. Each attendee should be able to perform elementary operations, with guidance, and describe general hardware architecture and functionality of system. This course shall include, but not limited to, the following.
1. Theory of operations.
  2. Hardware architecture.
  3. Operation of system.
  4. Operator commands.
  5. Control sequence programming.
  6. Database entry.
  7. Reports and logs.
  8. Alarm reports.
  9. Diagnostics.
- F. Training II: Provide training for operator equipment at project site for a total of 8 hours of instructions. This course shall consist of hands-on training under constant monitoring of instructor. Course content should duplicate Training I course as applied to installed system. Upon completion of this course, attendee should be fully proficient in operation of each system function. This course shall include, but not limited to, the following.
1. Physical layout of each piece of hardware.
  2. Troubleshooting and diagnostics procedures.
  3. Repair instructions.
  4. Preventive maintenance procedures and schedules.
  5. Calibration procedures.
- G. Training III: Provide training for a total of 8 hours between 3 and 6 months after project completion. Structure course to address specific topics that facility personnel need to discuss and to answer questions concerning operation of system. Upon completion of course, attendees should be fully proficient in system operation and have no unanswered questions regarding operation of installed system.

### 3.13 COMMISSIONING

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

SECTION 23 12 13

FACILITY FUEL-OIL DISPENSING PUMPS

**PART 1 - GENERAL**

- 1.1. FURNISHED BY CONTRACTOR INSTALLED BY CONTRACTOR (FCIC)
  - A. Facility Diesel Exhaust Fluids (DEF) Storage, Spill Containment and DEF Transfer pump System shall be furnished by contractor, installed by contractor (FCIC)
- 1.2. RELATED DOCUMENTS
  - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- 1.3. SYSTEM DESCRIPTION – SUMMARY
  - A. This section describes requirements for providing the equipment, labor and materials necessary to furnish and install Diesel Exhaust Fluids (DEF) Storage, Spill Containment and DEF Transfer pump System.
  - B. Requirements include furnishing and placing DEF storage, spill containment and transfer pump unit. These includes:
    1. Rolltop Drum spill containment system for 2 Drums.  
Equipment I.D. Tag: FA-06a, Qty. One (1)
    2. DEF Transfer Pump System, 55-gallon Drum.  
Equipment I.D. Tag: FA-06b, Qty. One (1)
- 1.4. PRODUCT
  - A. Rolltop Drum spill containment system for 2 Drums.  
Equipment I.D. Tag: FA-06a, Qty. One (1)
    1. Furnish a roll top drum storage and spill containment for two (2) 55-gallon drums. The containment sump shall have a capacity to capture a minimum of 66 gal. DEF spill.
    2. The containment pallet shall have a two-way forklift pocket for easy handling.
    3. Basic dimension: 67-1/4in L x 41-1/4 in W x 74in H
    4. Body and Grate material: Polyethylene
    5. Submit shop drawings and product data on all components and pump system to CONTRACTOR for approval, prior to ordering materials and components.
    6. Obtain all necessary permits for DEF storage and dispensing system placement and fuel system plans approval from authority having jurisdiction.
    7. Provide complete system installation and checkout.
  - B. DEF Transfer Pump System, 55-gallon Drum.  
Equipment I.D. Tag: FA-06b, Qty. One (1)
    1. Furnish a DEF transfer pump system for a 55-gallon drum.
    2. The roll top spill containment system shall contain two (2) DEF storage drums with DEF transfer pump/dispensing attached securely in a 55-gallon drum.
    3. Submit shop drawings and product data on all components and pump system to CONTRACTOR for approval, prior to ordering materials and components.
    4. Obtain all necessary permits for DEF storage and dispensing system placement and fuel system plans approval from authority having jurisdiction.
    5. Provide complete system installation and checkout.
- 1.5. SUBMITTALS
  - A. Submit product data and shop drawings on all components proposed for placement within 28 days after contract award to CONTRACTOR.
- 1.6. QUALITY ASSURANCE
  - A. All work shall be performed by skilled mechanics experienced in the installation and start-up of dispensing system.

1. Provide a list of at least five bulk DEF all in one storage/dispensing fuel pump system installations of a similar scope and complexity.
2. Approved fuel system plans shall be received from the authority having jurisdiction prior to purchasing equipment and materials.
3. Bulk All in One DEF Dispenser/Storage shall be activated only in presence of an authorized dispenser representation. Contractor has sole responsibility for damage to dispenser if this instruction is not followed.

1.7. WARRANTIES

- A. Provide 1-year limited warranty on all other DEF dispensing pump components and accessories.

1.8. MAINTENANCE/OPERATION

- A. Deliver a complete set of operating and maintenance manuals for all components of the DEF dispensing pump system to the CONTRACTOR.
- B. Deliver a complete set of manufacturer's recommended spare parts and specialty maintenance tools to the OWNER.

**PART 2 - PRODUCTS**

2.1. Roll Top DEF drum containment system, for two (2) drums

Equipment I.D. Tag: FA-07a, Qty. One (1)

- A. Provide an Ultratech roll top DEF drum spill containment system for two (2) drums.
- B. Install DEF spill containment system in accordance with the applicable provisions and standards of 40 CFR 264.175, 40 CFR 122.26 and shall support EPA and SPCC compliance.
- C. The containment sump that captures liquid spill shall have 66-gallon spill capacity and a roll-top door that is used to access DEF drums inside.
- D. The containment system shall have a double door allowing easy loading and unloading of drums.
- E. The pallets shall include a drain to remove liquids collected in the sump.

2.2. DEF Transfer Pump System From a 55 Gallon Drum

Equipment I.D. Tag: FA-07b, Qty. One (1)

- A. DEF transfer pump shall include a 40" polypropylene tube for 55-gallon drums.
- B. Splash proof motor with 3-position switch (Low-off-High), 3/4 inch x 8-foot hose, stainless steel clamps, sealed bung adapter
- C. Stainless steel nozzle and 3/4 inch stainless steel swivel adapter.
- D. Electric Power requirement: 110V, single phase for a 1/3 HP and 2 speed motor.

2.3. Manufacturer's Reference:

- A. Prime Manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.

1. Grainger Industrial Supply

3013 Walnut St,  
Everett, WA 98201

Website: [www.grainger.com](http://www.grainger.com)

Model: 9613 for Roll Top DEF drums storage and Spill containment system

2. Basco

2595 Palmer Ave.  
University Park, IL 60484

Website: [www.bascousa.com](http://www.bascousa.com)

Model: DEF009 for DEF Transfer pump system 55 Gallon

**PART 3 - EXECUTION**

3.1. Installation

- A. Installation – DEF storage, dispensing pump and spill containment system Locate a DEF storage, dispensing pump and spill containment system on the concrete fuel island. DEF dispenser pump and storage unit to be placed level on the island.
- B. Mount signage, decals, and operating instructions.

3.2. Inspection and Testing

- A. Obtain installation approval from the Authority having jurisdiction prior to turning the system over to the OWNER.

3.3. System Verification

- A. Place and connect DEF transfer pump components in strict accordance with the manufacturer's installation instructions.
- B. Verify placement of pump on the drum and required electrical connection for proper operation of the unit.

END OF SECTION

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SECTION 23 12 16

FACILITY GASOLINE DISPENSING PUMPS

**PART 1 - GENERAL**

1.1. FURNISHED BY CONTRACTOR INSTALLED BY CONTRACTOR (FCIC)

- A. Facility Fuel Dispensing pumps and all other related equipment shall be furnished by contractor, installed by contractor (FCIC)

1.2. RELATED DOCUMENTS

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

1.3. SYSTEM DESCRIPTION – SUMMARY

- A. This section describes requirements for providing the equipment, labor and materials necessary to furnish and install a complete facility fuel dispensing system for two products, i.e. gasoline and diesel.
- B. Requirements include furnishing and installing all equipment and accessories necessary to make basic fuel dispensing for the facility fuel station. These includes:
  - 1. Fuel Dispenser two (2) Product/two (2) Hose, digital display with Pulse output Equipment I.D. Tag: FA-04, Qty. Two (2)
  - 2. Cardlock system Equipment I.D. Tag: FA-05, Qty. One (1)

1.4. PRODUCT

- A. Fuel Dispenser two (2) Product/two (2) Hose, digital display with Pulse output Equipment I.D. Tag: FA-04, Qty. Two (2)
  - 1. Furnish and install two product fuel dispensing system along with a 20,000-gal. above ground horizontal fuel storage tank and fill boxes serving both fuel types, piping (both above and below grade), submersible pumps, accessories and any other component parts reasonably incidental to providing a complete fuel dispensing system.
  - 2. First 5,000 gal. tank compartment shall be designed and designated for unleaded gasoline fuel storage. The second 15,000 gal. tank compartment shall be designed and designated for diesel fuel storage.
  - 3. Piping shall be arranged to minimize the length of product lines.
  - 4. Fuel storage tank to be secured to concrete foundations designed by others.
  - 5. The city will procure all permits for fuel system installation and approvals from authorities having jurisdiction.
  - 6. Submit shop drawings and product data on all components for District approval, prior to ordering materials and components.
- B. Cardlock System Equipment I.D. Tag: FA-05, Qty. Two (1)

Cardlock System is required to provide a real-time transaction and fleet data, accessible from a secure cloud hosted FMLive software.

  - 1. Hardware requirement
    - a. Mechanical dispensers with tank monitor units
    - b. Automatic Firmware updates
    - c. Advanced Surge Protection
  - 2. Compliance
    - a. Weights and Measures compliant
    - b. Fuel Security and Authorization
    - c. EMV Compliant
  - 3. Passive Automated Fueling (AIM)
    - a. AIM support

- b. Dash Odometer
- c. Vehicle Telematics/Diagnostic Trouble Codes (DTCs)
- 4. Software Platform
  - a. FMLive (Cloud Based)
- 5. Cardlock system requirement
  - a. Invoicing, report and exports
  - b. Inventory Management and user accountability
  - c. Real-time data and alerts
  - d. Customizable roles and permissions setting
- 6. Fleet card authorization
- 7. Certification
  - a. UL-1238 Ed.6
  - b. CSA C22.2 No. 22 (R2014)
  - c. CSA C22 No. 142(R2013)
  - d. EN 61010-1:2010
  - e. FCC certified

#### 1.5. SUBMITTALS

- A. Submit product data and shop drawings on all components proposed for installation within 10 days after contract award.

#### 1.6. QUALITY ASSURANCE

- A. Provide a list of at least five fuel system installations of a similar scope and complexity.

#### 1.7. WARRANTIES

- A. Provide a 30-year limited warranty on exterior tank integrity for double wall tanks.
- B. Provide at minimum a 1-year limited warranty on all other tank components and accessories.

#### 1.8. MAINTENANCE/OPERATION

- A. Provide and deliver a complete set of operating and maintenance manuals for all components of the fuel delivery system to the city. See section 017823 for specific requirements.
- B. Deliver a complete set of manufacturer's recommended spare parts and specialty maintenance tools to the city.

### PART 2 - PRODUCTS

#### 2.1. FLEXIBLE HOSE

- A. Hose shall be all stainless-steel braid and inner-core, 100 psi at 1,000 degrees F, UL 842 listed. Hose shall be rated for suction use.
- B. Acceptable Manufacturers: OPW or approved equivalent.

#### 2.2. DISPENSERS AND ACCESSORIES

- A. Provide side mount hose w/ dual display at dispenser allowing for reading at either side of island for both fuel dispensers.
- B. Electronic Register, Two Product Twin Hose Gasoline and Diesel Dispenser with aboveground sump pump: Power reset and interlock; illuminated; on-off lever required to be in off position to return nozzle to holder; 10:1 pulser; glass area over meters only; 999.999-gallon register, 999,999 per meter/hose totalizer; solenoid contained within dispenser housing; 10-micron filter; ¾ inch diameter x 17-foot-long hose with swivel and breakaway; capable of 22 gpm flow; UL listed and labeled.
- C. Acceptable Fuel Dispenser Manufacturers: Wayne WA-3/G7203D/29GHJKUY1 or approved equivalent.
- D. Nozzles: Provide OPW or equivalent 11BP ¾" nozzles for the gasoline dispensers. Provide OPW or equivalent 11B ¾" nozzle for the diesel dispenser. Nozzles shall be capable of 22 gpm flow.



- E. Acceptable Swivel and Breakaway Manufacturers: OPW or approved equivalent.
- F. High Hose Retriever Assembly: OPW Retail Fueling Model 610B or approved equivalent.
- G. Pressure Reducing Valve
- H. Emergency stop switch with keyed reset.
- I. Any other devices and connections required to satisfy local code requirements.

### **PART 3 - EXECUTION**

#### **3.1. INSTALLATION –DISPENSERS, AND ACCESSORIES**

- A. Install aboveground tank level with the support saddles on a 1-inch grout base.
- B. Install fill boxes, vapor recovery lines, accessories, and all piping to the three-compartment fuel storage tank.
- C. Install tank vents to a height required by code.
- D. Install submersible pumps and underground piping to the dispensers.
- E. Install a dispenser securely attached to anchor bolts set into a concrete island Size shall be specified in the dispenser manufacturer's installation instructions. Fuel dispenser to be installed level.
- F. Install leak detection system.
- G. Touch up any abrasions in the tank coating with the materials recommended by the coating system manufacturer. Field paint piping per OWNER'S directions.
- H. Mount signage, decals, and operating instructions.
- I. Provide programming and connections necessary to configure the replacement fuel storage and dispensing system with the existing tank monitor console and fuel management system.
- J. Coordinate with all underground utilities on-site.

#### **3.2. Inspection and Testing**

- A. Prior to tank installation, tighten all fittings and pneumatically test with 3 to 5 psi pressure.
- B. Apply soap solution to all seams, ribs, fittings, and visible dents. Observe for leaks.
- C. Obtain installation approval from the Authority having jurisdiction prior to turning the system over to the OWNER.

#### **3.3. System Verification**

- D. Install and connect level and leak detection system components in strict accordance with the manufacturer's installation instructions.
- E. Adjust and program all equipment setpoints and alarm levels in accordance with the manufacturer's designed procedures.
- F. Verify proper operation of all normal and alarm controls and annunciation devices.
- G. Verify proper connection of the leak detection system panel to the tank gauging system for proper operation of leak detection alarms.

END OF SECTION

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SECTION 23 13 23.16

FACILITY FUEL STORAGE TANKS – HORIZONTAL STEEL ABOVEGROUND FUEL-OIL STORAGE TANK

**PART 1 - GENERAL**

1.1 FURNISHED BY CONTRACTOR INSTALLED BY CONTRACTOR (FCIC)

- A. Horizontal Aboveground Diesel and Gasoline Fuel Storage Tank shall be furnished by contractor, installed by contractor (FCIC)

1.2 SYSTEM DESCRIPTION

A. Product

1. Furnish and install a two-compartment horizontal above ground fuel storage tank with a nominal capacity of 20,000 gallons. Fuel Station shall include fill box serving both fuel types/compartments, piping, submersible pumps, dispensers, accessories and any other reasonably incidental parts that are needed to provide a complete facility fuel dispensing system. The first part of compartment with a capacity of 5000 gallons shall be designed and designated for unleaded (gasoline) fuel storage, while the second compartment of 15,000 gallons shall be designed and designated for diesel fuel storage.
2. Piping shall be arranged to minimize the length of product suction lines with primary consideration given to the gasoline suction line, secondary consideration given to the diesel suction line.
3. Fuel storage tank to be secured to concrete foundations designed by others.
4. The City will procure all permits for fuel system installation and approvals from authorities having jurisdiction.

1.3 SUMMARY

- A. Facility aboveground fuel oil storage tank and all other equipments listed under 1.2 C shall be Furnished by Contractor, Installed by Contractor (FCIC)
- B. This section describes requirements for providing the equipment, labor and materials necessary to furnish and install a complete facility Fuel storage and dispensing system utilizing a fire tested round aboveground steel tank with secondary containment.
- C. Requirements include furnishing and installing all equipment and accessories necessary to make complete systems for the storage and dispensing of Gasoline and Diesel fuel for the facility. These includes:
1. 20,000 Gal. Double wall, Fire Protected (Thermally Insulated) above ground Storage Tank-Fireguard- Split 15K/5K Diesel and Unleaded/Gasoline Equipment I.D. Tag: FA-01, Qty. One (1)
  2. Diesel Fuel Fill Port and Spill Containment Equipment I.D. Tag: FA-02, Qty. One (1)
  3. Gasoline Fuel Fill Port and Spill Containment Equipment I.D. Tag: FA-03, Qty. One (1)
  4. All Other Accessories like: piping, underground equipment, tank venting, tank gauging, decals, tank monitoring, turbine assembly, submersible pumps, fuel level dip stick, alarm clock gage and emergency disconnect switch (emergency fuel shutoff switch).

1.4 DEFINITIONS

- A. AGREEMENT consists of the conditions of the contract between the Owner and the Contractor, including referenced specifications, drawings and related documents.
- B. AUTHORITY HAVING JURISDICTION is the states and local fire marshal, building official, health department, electrical inspector or any other having statutory jurisdiction over the project.
- C. CONSTRUCTION DOCUMENTS consist of the general and supplemental conditions, specifications, drawings, and any addenda issued prior to bidding.
- D. CONTRACTOR is the person, firm, or corporation with whom Owner has entered into the Agreement.
- E. FURNISH means the Contractor shall supply the item specified, at the job site, unloaded, and se-

- cured against damage, vandalism or theft.
- F. INSTALL means the Contractor shall perform all work required to place the equipment specified in operation, including installation, testing, calibration, and start-up.
  - G. OWNER is the person or entity identified as such in the Agreement.
  - H. PRODUCT means the liquid stored in and dispensed from the tank.
  - I. PROVIDE means the Contractor shall Furnish and Install the equipment specified, and perform all work necessary to provide a complete and functional system.
  - J. SPOIL means all material removed by demolition or excavating
  - K. SUBSTANTIAL COMPLETION is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently completed in accordance with the Contract Documents for the Owner to utilize the Work for its intended use.
  - L. WORK means all materials, equipment, construction and services required by the Contract, whether completed or partially completed.

#### 1.5 GENERAL REQUIREMENT AND COORDINATION

- A. Unless otherwise specified, equipment furnished under this section shall be provided and installed in compliance with the instructions of the manufacturer.
- B. The Contractor shall ensure that all equipment, accessories and installation materials comply with the specification and that adequate provision is made in the tank design and fabrication for mounting the specified system equipment and accessories.
- C. The Contractor is solely responsible for construction means, methods, techniques, sequences and procedures and for safety precautions and programs.
- D. The contractor shall provide all labor, equipment and material required to provide a complete and functional system.
- E. To avoid delays in construction, the Contractor shall ensure that all components of the system are available at the time of installation.
- F. The Contractor shall coordinate his work with other work being performed at the construction site and minimize interference with the Owner's normal activities which may continue during construction.
- G. The Contractor shall obtain necessary permits, arrange for inspections and obtain approval of the appropriate Authority Having Jurisdiction over the work described.

#### 1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.7 SUBMITTALS

- A. The Contractor shall provide one (1) set of product data and shop drawings of the following system components for approval prior to ordering materials and components and before commencing construction.
  - 1. Shop drawings of the tank by the tank manufacturer. Include product data for shop and field touch-up primers.
  - 2. Assembly and installation drawings.
  - 3. Any other as required.
- B. The Contractor shall provide product data sheets and descriptive material for major components to be provided.
  - 1. Tank coatings.
  - 2. Pumps, valves and fittings.
  - 3. Piping, venting equipment, leak detection equipment, and overfill prevention equipment.
  - 4. Other system accessories as stated by the manufacturer
- C. Submittals shall be delivered to the city's Engineer within 10 days of notice to proceed. The Engineer shall review the drawings and return them to the Contractor approved, or with appropriate comments, within 14 days of receipt.

#### 1.8 QUALITY ASSURANCE AND WARRANTIES

- A. The Tank manufacturer shall provide a Third-Party Steel Tank Institute 30-year Warranty on exteri-

- or tank integrity for double wall tanks. A manufacturer's warranty is not acceptable.
- B. Provide a list of at least five fuel system installations of a similar scope and complexity.
- C. Provide at minimum, a 1-year limited warranty on all other tank components and accessories.

#### 1.9 CONSTRUCTION DOCUMENTATION

- A. At contract close-out, the Contractor shall provide three (3) sets of the following installation instructions for:
  - 1. 20,000 Gal. Above ground Horizontal, Round and Protected Split Fuel Tank
  - 2. Pumps, valves and fittings
  - 3. List of all other components which makes up a complete functional facility fuel dispensing system.
- B. The Contractor shall provide three (3) sets of manufacturers' system component operation and maintenance manual instructions.
- C. The Contractor shall provide record ("as-built") drawings and photographs of the following:
  - 1. All underground system components (if applicable).
  - 2. The completed tank system in place.
- D. The Contractor shall provide copies of all testing and inspection reports to the Owner prior to substantial completion.

### PART 2 - PRODUCTS/EQUIPMENTS

#### 2.1 FIREGUARD DOUBLE-WALL FIRE-PROTECTED ABOVEGROUND FUEL STORAGE TANK

Equipment I.D. Tag: FA-01, Qty. One (1)

- A. Provide double wall Fireguard, painted steel above ground fuel storage tank with a split compartment (15K/5K) for storage of diesel and unleaded gasoline respectively. Tank shall be atmospheric pressure type.
- B. Number and size of tank shall be one (1) 20,000 gallons (nominal) fuel tank for diesel 15,000 gal. and gasoline 5,000 gal. storage. Total tank dimension to be (diameter, length) 124 and 458 inches respectively with two 6 in tall saddle to support 124-inch diameter Fireguard Tank.
- C. Material (Construction) labeling:
  - 1. Material: carbon Steel ASTM A 36 OR A 569
  - 2. Material Thickness: Primary Tank- 1/4-inch, Primary Heads- 1/4-inch, Secondary Tank- 1/4 inch and Secondary Heads- 5/16 inch
- D. Surface Preparation/Coating:
  - 1. Interior Surface: SSPC-SP-3 Power tool clean welds, only remove all loose debris
  - 2. Exterior Surface: SSPC-SP-6 Commercial sand blast one coat of white Polyurethane.
- E. Tank Fittings and Accessories
  - 1. Four (4) Various type emergency tank vent
  - 2. Three (3) Emergency Vent, 10-inch 8 Oz and 8-inch 16oz.
  - 3. One (1) Flame Arrestor SS 90, 000SCFH@2.5 PSI UL525 certified
  - 4. One (1) Overfill Alarm, Tank gauging, Decal, Tank monitoring, 2-inch w/float
  - 5. One (1) Alarm acknowledgement switch
- F. Submersible Pumps
  - 1. Two (2) submersible pumps
  - 2. Two (2) Turbine pump Assembly, 3/4 HP fixed speed
  - 3. Single-phase control box w/lockout switch, 120 volts coil up to 2 HP
- G. Approved Manufacturers:
  - 1. Vendor: Shields Harper & Co.  
Manufacturer: Regal Tanks USA Inc.  
4591, Pacheco Blvd  
Martinez, CA 94553,  
Phone: 206) 489-2373,  
Website: [www.shieldsharper.com](http://www.shieldsharper.com)  
Model: SE-REGAL
  - 2. Approved Equal must be approved by Engineer 30 days prior to bid date.
  - 3. Manufacturer must have certified ISO 9001 Quality System in place 60 days prior to award.

- H. Construct tanks in accordance with the applicable provisions of UL 142 and 2085, IFC, STI F941, NFPA 30, and NFPA 30A.
- I. Construct tank in a horizontal configuration secured to concrete foundations designed and installed under a separate contract.
- J. Tank shall be cylindrical in shape.

## 2.2 GASOLINE AND DIESEL FUEL FILL PORT AND SPILL CONTAINMENT

Equipment I.D. Tag: FA-02 and FA-03, Qty. One (1) Each

- A. Remote Fill containers shall have 15-gallon capacity each with single connection in 2-inch, 3 inch or 4-inch female threads.
- B. Shall have gas spring cylinder feature to hold the lid in the up position when fueling.
- C. The containment box shall be lockable with a padlock and shall have a weather-tight enclosure and vent cover.
- D. Base to centerline connection height 30 inch to 48-inch pedestal model.
- E. Container 22-1/2-inch-wide x 24-inch-deep x 24-1/4-inch height.
- F. Material of construction
  - 1. Container and Lid: 12-gauge steel, powder coated white
  - 2. Pipe connection: Powder coated connection
  - 3. Pedestal mount: Schedule 40 steel pipe, powder coated steel white
  - 4. Ball valve: Brass
  - 5. Gasket: Teflon
- G. Code compliance: CAN-ULC-S663-11; Florida DEP EQ 535

## 2.3 PIPING

- A. Above ground piping
  - 1. Product pipe shall be scheduled 40, ASTM A 53 standard weight black steel with class 300 fittings.
- B. Under-ground piping (if applicable)
  - 1. Product pipe shall be F.R.P red thread 11A pipe with fittings. Contractor shall install per manufacturer's instructions.
  - 2. Acceptable piping manufacturer: Smith Fiberglass or approved equivalent.
- C. Handling of pipe and fittings
  - 1. All piping shall conform to pipe manufacturer's specifications and installation guidelines.
  - 2. Fiberglass Pipe: Protect against abrasions from sharp or hard objects, impact damage from improper storage, transporting, layout or backfilling. Inspect all pipe for damage prior to using in the piping system.
  - 3. Steel pipe and fittings: Protect against damage to protective coating/wrapping.

## 2.4 PERFORMANCE REQUIREMENTS

- A. The listed assembly shall meet the requirements for "fire protected" tank as defined by NFPA 30.
- B. The tank shall consist of an inner steel wall and an outer steel wall with 3 inches of lightweight concrete insulation between the inner and outer tanks.
- C. The inner and outer steel wall shall be UL 142 and UL 2085 construction capable of providing containment of the primary storage tank's content.
- D. Concrete encased tanks or tanks with non-steel secondary containment materials will not be allowed.
- E. Steel outer wall of the tank shall be coated to prolong weather resistance and to further reduce maintenance needs as per the following: SSPC-SP-6 blast, Zinc Epoxy primer at 2-3mils DFT and Urethane at 4-6mils DFT.
- F. The storage tank and supports shall be delivered as a complete UL listed unit.
- G. The storage tank and supports shall meet all Uniform Building Code requirements.
- H. Tank shall be designed for use aboveground and include integral secondary containment.
- I. The Contractor shall register each tank and serial number with Steel Tank Institute in accordance with instructions provided by the manufacturer with the tank.
- J. Required emergency venting devices must be provided and installed by the tank manufacturer

prior to shipment.

- K. Provide an interstitial monitoring tube for monitoring the tank's interstice for liquids.

## 2.5 VENTING REQUIREMENTS

- A. Provide one (1) normal atmospheric or pressure/vacuum vent for the primary tank.
1. Vents shall discharge upward or laterally, and be protected from intrusion of rain.
  2. When applicable, tanks located in Stage II Vapor Recovery mandated air quality areas shall be provided with pressure/vacuum vents.
  3. Vents for tanks containing Class 1 liquids shall terminate at least 12 feet above ground level and be located at least five feet from building openings.
  4. Vent installation shall comply with applicable sections of the fire and mechanical codes, including, but not limited to, NFPA 30A (2-4.5. e) or NFPA 30 (2-3.5).
- B. Provide one (1) emergency vent for each primary tank or primary tank compartment.
1. Vent size shall be determined by the tank configuration, the primary tank capacity, and the product stored.
  2. Emergency venting shall comply with provisions of NFPA 30A or NFPA 30.
- C. Provide one (1) emergency vent for each secondary containment tank interstice.
1. The venting capacity is determined by the tank configuration, secondary tank capacity, and the product stored.
  2. Emergency venting shall comply with provisions of NFPA 30A, NFPA 30, and UL 142.
  3. Vents shall be located as close to the center of the tank as possible.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Familiarity with the Site.
1. Contractor shall familiarize himself with the location of all public utility facilities and structures that may be found in the vicinity of the construction.
  2. The Contractor shall conduct his operation to avoid damage to the utilities or structures. Should any damage occur due to the Contractor's operations, repairs shall be made at the Contractor's expense in a manner acceptable to the Owner.
  3. The Contractor is responsible for meeting all the requirements established by the agencies for utility work, as well as work affecting utilities and other government agencies.

### 3.2 SITE PREPARATION

- A. The site shall be prepared to ensure adequate support for the tank system and drainage of surface water.
1. The foundation and tank supports shall be capable of supporting the weight of the tank and associated equipment when full.
  2. The foundation may be comprised of concrete, asphalt, gravel or other stable material designed to prevent tank movement, and must be rated for the seismic zone of the site.

### 3.3 TESTING

- A. The Contractor is responsible for testing all installed systems for liquid tightness and proper operation.
- B. Test each component of the system for calibration, tightness and proper operation in accordance with the instructions of the component manufacturer.
- C. Obtain installation approval from the Authority having jurisdiction prior to turning the system over to the OWNER.
- D. Testing shall be documented by the Contractor and witnessed by the Engineer.

### 3.4 SYSTEM VERIFICATION

- A. Install and connect level and leak detection system components in strict accordance with the manufacturer's installation instructions.
- B. Adjust and program all equipment setpoints and alarm levels in accordance with the manufactur-

- er's designed procedures.
- C. Verify proper operation of all normal and alarm controls and annunciation devices
  - D. Verify proper connection of the leak detection system panel to the tank gauging system for proper operation of leak detection alarms.

END OF SECTION 231323.16



SECTION 23 35 16  
HOSE REEL EQUIPMENT

**PART 1 - GENERAL**

1.1 FURNISHED BY CONTRACTOR INSTALLED BY CONTRACTOR (FCIC)

- A. Hose Reel Equipment shall be Furnished by Contractor, Installed by Contractor (FCIC)

1.2 SYSTEM DESCRIPTION

- A. Equipment items are listed below by Equipment I.D. Tag.
1. Wall Mounted Exhausted Hose Reel,  
Equipment I.D. Tag: MB-01 [Qty: Two (2)]
  2. Wall Mounted Air Hose Reel,  
Equipment I.D. Tag: MB-02, FS-08 and CS-08 [Qty: Four (4)]
- B. Description  
This section includes the specifications for Hose Reel Equipment that shall be installed on the wall for servicing various assorted vehicles of different sizes and weights.
- C. Seismic Calculations  
For seismic calculations, Reference general seismic design criteria noted on Sheet S0.1 Division 1 – General, A.9.
- D. List of Applicable Forms  
The General Conditions, Supplementary Conditions, Instructions to Bidders, Bid Form, all apply to these bid items.

1.3 DESCRIPTION OF WORK

- A. List of Work
1. The extent of the Work is shown on the drawings and is defined to include (but not by way of limitations) all labor, materials, freight, unloading, equipment, taxes, permits and supervision required for equipment and installation.
- B. Coordination
1. Contractor's Responsibility: It will be the Contractor's responsibility to verify and establish a detailed installation schedule.
  2. Field Check: ALL BUILDING AND EQUIPMENT LAYOUT DIMENSIONS SHALL BE FIELD CHECKED AND VERIFIED BY CONTRACTOR PRIOR TO START OF INSTALLATION. NOTIFY THE CONSULTANT AND OWNER OF ANY DISCREPANCIES OR CONDITIONS AFFECTING MATERIALS AND/OR INSTALLATION WITHIN TEN (10) DAYS. IF A CONDITION EXISTS AND THE CONSULTANT OR OWNER IS NOT NOTIFIED THE ADDITIONAL COST TO CORRECT THE INSTALLATION IN ACCORDANCE WITH THE REQUIREMENTS OF THE OWNER WILL BE THAT OF THE CONTRACTOR.
  3. Delivery and Unloading: The Hose Reel Contractor shall be responsible for coordinating the delivery and unloading of the equipment to the job-site with the General Contractor to eliminate demurrage charges, unless authorized by the Owner or the Consultant. In order to eliminate disruption to the ongoing operations and prevent interference of dock access by trucks entering and leaving the site, temporary staging of materials will be provided outside of the building at a location designated by the Owner. The Hose Reel Contractor shall provide storage facilities (i.e. covers, closed containers) to protect equipment from the elements (i.e. dust, dirt, rain, ice, snow, etc.) as necessary. Interior staging of equipment will be kept to a minimum so as not to disrupt ongoing operations.

#### 1.4 QUALITY ASSURANCE

##### A. Standards

1. Equipment Standards: The equipment covered by these Specifications shall be designed, assembled, tested and installed in accordance with the latest applicable standards, including:
  - a. American National Standards Institute (ANSI).
  - b. American Iron and Steel Institute.
    - 1) Specification for Design of Cold-Formed Steel Association - "Structural Members" 2015 edition.
2. International Building Code (IBC)
  - a. International Building Code including current Building Code Amendments. (2015 Edition)
3. Seismic Zone
  - a. The seismic zone for the project is Seismic Zone 3 with near source distance factors applied.
4. Materials
  - a. All materials furnished shall be new, free from defects, and UL-Approved where such approval is granted to the equipment to be furnished.
5. Federal Inspection
  - a. Latest published applicable Federal Specifications.
6. OSHA
  - a. Applicable OSHA Specifications.
7. Building and Safety Codes
  - a. Any applicable local building and safety codes pertaining to the Work.

##### B. Workmanship

1. Trade Methods: Use the best trade methods throughout. Work evidencing substandard workmanship shall be corrected or replaced by the Contractor at the Contractor's expense, per the General Conditions.

##### C. Touch Up Paint: The method for the touch up of paint shall follow specifications section 3.2 Field Painting.

##### D. GUARANTEES

1. Warranty:
  - a. Warranty shall be the manufacturer's standard warranty and shall be specified by the Contractor in the contents of the proposal.
  - b. The contractor shall provide an extended warranty for a period of three (3) years from Date of Acceptance.
  - c. QUALITY OF MATERIALS AND EQUIPMENT: The Contractor guarantees the material and equipment delivered under the Contract to be free from defects in design or workmanship and against damages caused prior to final inspection. Unless otherwise specified, this guarantee extends for a period of three (3) years from the Date of Acceptance for both labor and materials.
  - d. REPAIRING DEFECTS: The Contractor shall promptly repair or replace all defective or damaged items delivered under the Contract. The Hose Reel Contractor may elect to have any replaced item returned to his/her plant at his/her expense.

#### 1.5 SUBMITTALS

- ##### A. Product Data: Submit latest edition of Hose Reel data sheet and outline drawing with the proposal.
1. Shop Drawings:
    - a. Shop Drawings, as stated in the General Conditions, shall include, but need not be limited to:

- b. Installation Plan: Proposed installation plan of equipment, including location and dimensions of new equipment clearly identified. It will be the Contractor's responsibility to verify and establish a detailed installation schedule per the General Conditions.
  - c. Dimensions: Plan views showing all equipment dimensions along with any aisle clearance dimensions.
  - d. Bill of Materials: Bill of Materials per the General Conditions.
  - e. Approved Shop Drawings
  - f. It will be the Contractor's responsibility to obtain approved shop drawings signed by the Consultant and/or Owner per the General Conditions prior to fabrication.
2. Manufacturer's Reference:
- a. Prime Manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.  
JohnDow EuroVent  
151 Snyder Ave.  
Barberton, OH 44203  
Phone: (800) 433-0708  
Website: <https://www.euroventexhaust.com/>  
Hose Reel Model: CAR-ALU-HD-6 BLUE w/adapters-6-VG  
Ventilation Fan: AF-12 w/reducer 6X7-RED and Motor Starter  
  
REELCRAFT Industries, Inc.  
2842 E. Business Hwy. 30  
Columbia City, IN 46725  
Phone: (800) 444-3134  
Website: <https://www.REELCRAFT.com/>  
Low Pressure Air/Water Reels: 81100 OLP
3. Other manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers may be considered as equal.

## PART 2 - PRODUCTS

### 2.1 HOSE REEL EQUIPMENT GENERAL

- A. The Contractor shall provide the following:
  1. List of Required Items
    - a. New Hose Reel as shown on the drawings, including freight, unloading, installation, touch-up painting, cleaning, and other equipment necessary to complete the system.
- B. Quantity and Capacity
  1. See drawings for equipment location and configuration.
- C. Standard Designs
  1. Components shall be of standard design and fabrication by the manufacturer so that all may be replaced or purchased at a future date without special charges or extended deliveries.
  2. The Bill of Materials for this Work is to be determined by the Contractor from the bid drawings and contents of the Specifications. Hose Reel Contractor to verify all information.
- D. Codes
  1. The Hose Reel shall be designed and installed to the exact standards of the manufacturer and in all cases shall conform to applicable codes.
- E. Loads and Capacity
  1. The Hose Reel shall be designed to handle specified loads.

- F. Install
  - 1. The shipment of the Hose Reel shall include all components to allow immediate install upon receipt.
- G. Anchoring
  - 1. All work must be rigid and anchored securely. Method of attachment to be approved prior to installation.
- H. Touch Up
  - 1. The Hose Reel Contractor shall touch up any other Contractor's work damaged during the process per section 3.02 Field Painting.

## 2.2 Wall Mounted Exhaust and Air Hose Reels,

- A. General: **Equipment Tag # MB-01 Exhaust Hose Reel [Qty. two (2)]**
  - 1. Description: Heavy Duty Hose Exhaust Reel typically used in commercial Vehicle Maintenance and Repair Shops.
  - 2. Physical Data:
    - a. Overall Dimensions:
      - 1) Width: 38 3/4"
      - 2) Depth: 2'-5 3/16"
      - 3) Height: 23 5/8"
    - b. Duct Size: 6"
    - c. Duct length: 25'-0"
  - 3. Features and Construction:
    - a. 2-year Manufacturer's warranty
  - 4. Finish: Manufactures Standard
- B. General: **Equipment Tag # MB-01 Exhaust Fan with SS hose Adapter [Qty. two (2)]**
  - 1. Description: Heavy Duty Hose Exhaust Reel Fan typically used in commercial Vehicle Maintenance and Repair Shops.
  - 2. Physical Data:
    - a. Overall Dimensions:
      - 1) Width: 17 1/4"
      - 2) Depth: 18 1/8"
      - 3) Height: 20"
    - b. Inlet Duct Size: 6"
    - c. Output Duct Size: 7"
    - d. Motor Size: .50 HP
    - e. Power Requirements: 460V, 1.1 FLA 60 Hz 3ph
  - 3. Features and Construction:
    - a. 2-year Manufacturer's warranty
  - 4. Finish: Manufactures Standard
- C. General: **Equipment Tag # MB-02, FS-08 and CS-08 Heavy-Duty Medium-Pressure Spring Retractable Air Hose Reel [Qty. Four (4)]**
  - 1. Description: Heavy Duty Retractable Air Hose Reel typically used in commercial Vehicle Maintenance and Repair Shops.
  - 2. Physical Data:
    - a. Overall Dimensions:
      - 1) Width: 10.5"
      - 2) Depth: 24"
      - 3) Height: 25 3/8"
  - 3. Features and Construction:
    - a. Hose Anti Latch-Out
    - b. Guide Arm
    - c. Structurally Reinforced Guide Arm and Pedestal Base
    - d. Containerized Spring Assembly

- e. Dual Sealed Ball bearings
- f. 2-year Manufacturer's warranty
- 4. Finish: Manufactures Standard

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

##### A. Coordination

- 1. Each Contractor must give careful consideration to the ongoing facility operations and the work of other contractors during the entire project and shall organize his/her work so that it will not interfere with ongoing operations or interfere with or delay the work of others. Minimal disruption to ongoing operations is a priority. It is imperative that the schedule be maintained with any changes coordinated promptly with the General Contractor, Owner, and Consultant.

##### B. General Description

- 1. The Hose Reel shall be installed true and properly aligned complete in all details and in accordance with the specifications, manufacturer's recommendations, and the drawings.

##### C. Installation Routine

- 1. Installation shall include unloading, checking and security of equipment prior to erection, shimming, complete anchoring, touch up and cleaning. The Contractor shall provide storage facilities (i.e. covers, closed containers) to protect equipment from the elements (i.e. dust, dirt, rain, snow, etc.). Contractor shall use a transfer system to bring materials inside the building that is supplied by the Contractor. Contractor to ensure no damage to the overhead door, floor, facility or equipment.

##### D. Tools and Equipment

- 1. The Contractor shall be responsible to provide all tools and equipment necessary for a complete and satisfactory installation. All wheeled and rolling equipment used in the building during construction (after slab on grade has been poured) must use wheel wraps as drip diapers or similar to protect floor from rubber marking and equipment spillage of oil or other substances.

##### E. Construction, lifts, man Lifts and Vehicles

- 1. All wheeled and rolling equipment used in the building during construction (after slab on grade has been poured) must use wheel wraps as drip diapers or similar to protect floor from rubber marking and equipment spillage of oil or other substances.

##### F. Permits and Inspection

- 1. Contractor shall obtain, and pay for, all necessary permit fees and inspections required by the State or local municipalities.

##### G. Damaged Materials

- 1. Claims, due to freight damage, are the responsibility of Hose Reel Contractor. This includes any damage that is not evident at the time of the unloading of the equipment (i.e. concealed damage). Should such damage be uncovered, the Contractor must act promptly to repair/replace damaged equipment to minimize any delay to the schedule. Any added cost due to a delay is the responsibility of the Contractor.

##### H. Debris Disposal

- 1. It shall be the responsibility of the Hose Reel Contractor to remove any debris resulting from his/her work on each and every workday to a pre-designated disposal area. This shall include all waste generated by the installer or any of his/her personnel, shipping containers, and/or construction materials. The Contractor shall broom clean the area each work day to leave the work area clean and allow the Owner access to scrub the floor. This will include organizing the materials not yet incorporated in the Work. At the completion of the work the Contractor shall remove all of his/her waste materials and rubbish from and about the project, as well as all his/her tools, construction equipment, machinery.

##### I. Clearance

1. The Contractor shall be responsible for maintaining all clearances specified on the drawings.
  - J. Modifications
    1. The Contractor shall be responsible for the suitability of any Hose Reel component modifications required after installation begins. All modifications must be submitted and approved by the Owner and Consultant prior to beginning Work. Modifications done by others must be approved by the Contractor prior to modification. The Contractor shall be responsible for such a modification by others.
  - K. Contractor's Survey of Damage
    1. The Contractor shall conduct a survey of his/her work each and every workday morning and note any and all damages observed. Any damages must be reported to the General Contractor and the Owner by 9:00 a.m. Damages not reported within this time frame will be the contractor's responsibility.
  - L. Marking Restrictions
    1. Under no circumstances will a magic marker, sharpie or any other permanent marking device, which will absorb into concrete, paint or decking, be used for marking equipment locations. All markings must be water soluble and removable. The contractor is responsible to remove these markings prior to completing the Punch List
  - M. Installation
    1. The Owner shall have the option of performing his/her own Hose Reel installation.
- 3.2 Field Painting
- A. Cleaning
    1. All surfaces to be painted must be thoroughly cleansed of rust, scale, oil, grease, dirt, welding flash and all other forms of dirt detrimental to good painting practices.
  - B. Touch-Ups
    1. After the installations are complete, the Contractor shall touch-up any components that were damaged but only with owners/representative approval. Finish to match factory finish.

END OF SECTION

**SECTION 23 21 16  
PIPING SPECIALTIES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes pipe specialties that apply to multiple systems. Specialty components specific to single system are specified in that particular section.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASME B31.1, Power Piping.
  - 2. ASTM A 36, Standard Specification for Carbon Structural Steel.
  - 3. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
  - 4. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 5. MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
  - 6. NFPA 255, Surface Burning Characteristics Building Materials.
  - 7. UL 723, Tests for Surface Burning Characteristics of Building Materials.
- C. Pipe hangers and clamps and related components installed in ceiling spaces used as a return air plenum shall have ratings per NFPA 255, ASTM E 84, and UL 723 with flame spread rating not greater than 25 and smoke developed rating not greater than 50.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following. Include MSS reference in product data for pipe hangers and supports.
  - 1. Pipe hangers and supports.
  - 2. Engineered secondary pipe positions and support systems.
  - 3. Pipe supports on roof.
  - 4. Insulated pipe hangers.
  - 5. Y-type strainers.
  - 6. Thermometers.
  - 7. Pressure gages.
  - 8. Temperature/pressure test ports.
  - 9. Pipe escutcheons.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Furnish factory-fabricated piping specialties recommended by manufacturers for use in services indicated. Furnish piping specialties of types and pressure ratings indicated but rated at not less than 125 psig WSP to comply with installation requirements. Furnish sizes as indicated with connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Contractor's option. Refer to other sections for higher working steam pressures.
- B. Except as otherwise indicated, furnish factory-fabricated pipe hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected to suit piping systems, in accordance with MSS SP-58 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit around piping insulation with saddle and shield for insulated piping and where insulated pipe hangers are used.
- C. Materials: Match piping material at point of contact with piping:
  - 1. Carbon steel, cast or malleable iron for black steel pipe.
  - 2. Carbon steel, cast or malleable iron with epoxy coating galvanized steel pipe and zinc coating for piping installed outdoors.
  - 3. Carbon steel or malleable iron with copper finish or plastic coated, or copper for copper pipe.

2.02 PIPE HANGERS AND SUPPORTS

- A. Horizontal Piping:
  - 1. Adjustable Steel Clevises: MSS SP-58 Type 1.
  - 2. Yoke Type Pipe Clamps: MSS SP-58 Type 2.
  - 3. Steel Pipe Clamps: MSS SP-58 Type 4.
  - 4. J-Hangers: MSS SP-58 Type 5.
  - 5. Adjustable Band Hangers: MSS SP-58 Type 9.
  - 6. Split Pipe Rings: MSS SP-58 Type 11.
  - 7. Pipe Slides and Slide Plates: MSS SP-58 Type 35, including glide type plate.
  - 8. Trapeze Hanger: MSS SP-58 Type 59, shop or field fabricated made from structural-steel shapes with hanger rods, nuts, saddles, and U-bolts. Comply with requirements in Section 200510 for formed steel channels.
  - 9. Finish: Galvanized steel.
- B. Hanger Rods: Hot rolled steel, ASTM A 36. Refer to Article "Hanger Rod Schedule" in this section.
- C. Vertical Pipes at Walls and Columns: Supporting pipes from walls and columns not acceptable.
- D. Hanger Rod Attachments:
  - 1. Steel Turnbuckles: MSS SP-58 Type 13.
  - 2. Steel Clevises: MSS SP-58 Type 14.



- E. Building Attachments:
1. Steel or Malleable Concrete Inserts: MSS SP-58 Type 18 or UL listed.
  2. Top Beam C-Clamps: MSS SP-58 Type 19.
  3. Side Beam or Channel Clamps: MSS SP-58 Type 20.
  4. C-Clamps: MSS SP-58 Type 23.
- F. Cushion Clamp for Un-Insulated Pipes:
1. Description: Steel clamp assembly with cushion insert for use with formed steel channels. Clamp with electro-galvanized finish. Cushion insert manufactured from thermoplastic elastomer for temperature range from 50 F to 300 F. Unistrut Cush-A-Clamp or approved.
- G. Manufacturers: Anvil International, Unistrut®, Power-Strut®, Superstrut®, PHD Manufacturing Inc., Cooper Industries B-Line, TOLCO™, Simpson Strong-Tie, or approved.

### 2.03 ENGINEERED SECONDARY PIPE POSITIONING AND SUPPORT SYSTEMS

- A. General: Support of piping accomplished by engineered products specific to each application. Typical applications:
1. Vertical and horizontal branch piping serving plumbing fixtures.
  2. Piping penetrations through wood and steel stud framing.
  3. Trapeze hanger with horizontal piping either above or below the strut.
- B. Manufacturers: HOLDRITE® or approved.

### 2.04 PIPE SUPPORTS ON ROOF

- A. Description: As detailed on the Drawings.
- B. Description: Factory assembly with 1 piece, injection molded polypropylene impact copolymer support shell attached to 1 inch thick non-marring, closed cell extruded polystyrene base. Each nominal 12 by 9 inch assembly capable of supporting up to 450 pounds.
- C. Manufacturer: Pipe-Ease Inc Quick Block™/E-Z Sleeper, Erico CADDY® PYRAMID, Roof Top® Blox , or approved.

### 2.05 INSULATED PIPE HANGERS

- A. Description: Hydrous calcium silicate or polyisocyanurate foam (urethane) insulation which covers 100 percent of the pipe and extends beyond overlapping full wrap galvanized steel or PVC jacket. Thickness of insulation same as specified in Section 230700 for specific pipe systems.
- B. Manufacturers: KB Enterprises SNAPP ITZ for both hot and cold pipe applications or approved.

**2.06 Y-TYPE STRAINERS**

- A. Description: Line size of connecting piping with ends matching piping system materials. Select strainers for minimum 125 psi working pressure. Include ASTM A 666 Type 304 stainless steel screens, unless specified otherwise, with 3/64 inch perforations at 233 per sq. in. and blowout connection with ball valve and capped nipple or gate valve with plug.
1. Threaded Ends, 2 Inch and Smaller for Steel Pipe: Cast iron body.
  2. Threaded or Solder Ends, 2 Inch and Smaller for Copper Pipe: Cast bronze body with brass screen.
  3. Flanged Ends, 2-1/2 Inch and Larger: Cast-iron body.
  4. Manufacturers: Armstrong Fluid Technology, Watts®, Crane, Hoffman Specialty®, Metraflex, Spirax Sarco, Nibco, or approved.

**2.07 THERMOMETERS**

- A. Description: Solar powered, 3/8 inch LCD digital display at 1 foot-candle, 1 percent or 1 degree (whichever is greater accuracy), minus 40 F to 300 F temperature range, recalibration by internal potentiometer. ABS case construction. Adjustable stem assembly, 3-1/2 or 6 inch length to suit installation requirements.
- B. Manufacturers: Weiss Instruments Inc. DVU Series or approved.
- C. Thermal Wells: Matched to thermometer stem. Brass, 3/4 inch NPT, extension neck length to extend 1 inch beyond the pipe insulation jacket. Well lengths shall cover a bulb insertion depth inside pipe across a minimum of 2/3 of pipe inside diameter.

**2.08 PRESSURE GAGES**

- A. Description: Solar powered, 5/8 inch LCD digital display at 1 foot-candle, 1/4 percent (first half) and 1/2 percent (second half) resolution, 0.5 percent accuracy over full scale, minus 15 F to 150 F temperature range. 4 1/2 inch round case with black safety glass and solid front. Adjustable stem assembly. Adjustable range.
- B. Manufacturers: Weiss Instruments DUGY Series or approved.
- C. Pressure Ranges: Maximum gage pressure not greater than 150 percent nor less than 110 percent of the anticipated maximum pressure at point of installation. Select range so that normal operating point is near mid-scale of gage range. Gages 0 to 100 psig, 1 psig maximum pressure increment per gage mark.
- D. Manufacturers: Weiss Instruments Inc., Loneragan, Weksler®, Marsh Instruments, Taylor Precision Products, AMETEK® U.S. Gauge, Ashcroft Inc., Trerice, Miljoco Corporation, or approved.

**2.09 TEMPERATURE/PRESSURE TEST PORTS (PETE'S PLUGS)**

- A. Description: Brass, 1/4 inch NPT with extension for insulated piping, length to suit insulation thickness.
- B. Manufacturers: Peterson Equipment Company, Inc. Pete's Plug® II, Sisco P/T Plug, or approved.

## 2.10 PIPE ESCUTCHEONS

- A. Description: Select with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated, and to completely cover pipe penetration hole in floors, walls or ceilings including pipe sleeve extension. Nickel or chrome finish for occupied areas and prime paint finish for unoccupied areas.
  - 1. Pipe Escutcheons for Moist Areas: For water-proof floors and areas where water and condensation can be expected to accumulate, cast brass or sheet brass escutcheons, solid or split hinged.
  - 2. Pipe Escutcheons for Dry Areas: Sheet steel escutcheons, solid or split hinged.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing the Work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

### 3.04 PIPE HANGERS AND SUPPORTS

- A. General: Install building attachments at required locations for piping support. Install additional supports at concentrated loads, including valves, flanges, guides, strainers, expansion joint and at changes in direction of piping. Install insulated pipe hangers for insulated hot pipes 2 inch and larger and for all sizes of insulated cold pipes specified in Section 230700.
- B. Install hangers, supports, clamps, attachments and engineered secondary pipe positioning and support systems to support piping securely from building structure. Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible, MSS SP-58 Type 59. Where piping of various sizes are supported by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Use of wire, perforated metal or scrap framing materials to support piping not acceptable.
- C. Install hangers and supports complete with necessary insert, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

- D. Spacing of Hangers and Supports:
1. Maximum spacing between supports for straight runs of piping listed in Article "Spacing of Hanger and Supports Schedule" in this section.
- E. Pipe Ring Diameter:
1. Uninsulated Pipes: Ring diameter to suit pipe size.
  2. Insulated Pipes: Ring diameter to suit outer diameter of insulated pipe hanger.
- F. Supporting Piping:
1. Support piping so that expansion and contraction will take place in direction desired without stressing pipe, joints, and connected equipment.
  2. Prevent vibration with vibration dampers and prevent undue strains on equipment served.
  3. Fabricate hangers used for support of 2 inch nominal pipe size and larger to permit adequate adjustment after erection while still supporting the load.
  4. Use wall brackets where pipes are adjacent to walls or other vertical surfaces which may be used for supports.
  5. Fabricate supports to carry weight of piping and fluid and to maintain proper alignment.
  6. Install inserts for supports in concrete. Powder-actuated inserts not allowed.
  7. Install hangers and supports for indicated pipe slope, and so that maximum pipe deflections allowed by ASME B31.1 are not exceeded.
  8. Hang individual pipes and multiple pipes by trapeze hangers separately from roof structure and not from the roof deck itself and not from work of other trades. Hanging pipes from ducts and equipment not acceptable.
  9. Install formed steel channel as specified in Section 230510 where required for pipe hangers and supports.
  10. Install supports for horizontal pipe within 1-1/2 inch of each elbow.

### 3.05 PIPE HANGER AND SUPPORT APPLICATIONS

- A. Horizontal Piping: Unless otherwise indicated, install the following types:
1. Adjustable Steel Clevis Hangers (MSS SP-58 Type 1): For suspension of noninsulated or insulated stationary pipes.
  2. Yoke Type Pipe Clamps (MSS SP-58 Type 2): For suspension of 120 F to 450 F pipes, 4 to 16 inch sizes, requiring up to 4 inch of insulation.
  3. Steel Pipe Clamps (MSS SP-58 Type 4): For suspension of cold and hot pipes, 1/2 to 24 inch sizes, if little or no insulation is required.
  4. J-Hangers (MSS SP-58 Type 5): For suspension of pipes, 1/2 to 4 inch sizes, to allow off-center closure for hanger installation before pipe erection.
  5. Adjustable Band Hangers (MSS SP-58 Type 9): For suspension of noninsulated stationary pipes, 1/2 to 8 inch sizes.
  6. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS SP-58 Type 11): For suspension of noninsulated stationary pipes, 3/8 to 8 inch sizes.
- B. Vertical-Piping Clamps: Unless otherwise indicated, install the following types:
1. Extension Pipe or Riser Clamps (MSS SP-58 Type 8): For support of pipe risers, 3/4 to 20 inch sizes.

2. Carbon- or Alloy-Steel Riser Clamps (MSS SP-58 Type 42): For support of pipe risers, 3/4 to NPS 20 inch sizes, if longer ends are required for riser clamps.
- C. Hanger-Rod Attachments: Unless otherwise indicated, install the following types:
1. Steel Turnbuckles (MSS SP-58 Type 13): For adjustment up to 6 inch for heavy loads.
  2. Steel Clevises (MSS SP-58 Type 14): For 120 F to 450 F piping installations.
- D. Building Attachments: Unless otherwise indicated, install the following types:
1. Steel or Malleable Concrete Inserts (MSS SP-58 Type 18 or UL listed): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS SP-58 Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS SP-58 Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. C-Clamps (MSS SP-58 Type 23): For structural shapes.

### 3.06 LOW PRESSURE Y-TYPE STRAINERS

- A. Install strainers full size of pipelines as indicated on drawings.

### 3.07 THERMOMETERS

- A. Install at the Following Locations:
1. Inlet and outlet of equipment where fluid changes temperatures except where temperature/pressure test ports are indicated on the Drawings.
  2. Other locations as indicated on the Drawings.
- B. Thermal Wells: Install in piping so that thermometer scale is readable by personnel from a normal standing position on floor or grating. Fill thermal well with heat transfer medium approved by thermometer manufacturer.

### 3.08 PRESSURE GAGES

- A. Install at the Following Locations:
1. Inlet to domestic water service.
  2. Inlet and outlet of pressure reducing valves.
  3. Other locations as indicated on the Drawings.
- B. Installation: Install (gage) needle valve, and snubber so gage dial is readable by personnel from normal standing position on floor or grating.

### 3.09 TEMPERATURE/PRESSURE TEST PORTS (PETE'S PLUGS)

- A. Installation: Install so that thermometer dial and pressure gage can be inserted and easily readable by personnel from normal standing position on floor or grating. Where installed in insulated pipes, install with coupling to extend test port through insulation and jacket.
- B. Installations at Equipment: Install immediately adjacent to equipment such that there are no fittings between test port and final equipment connection point.

- C. Installation at Miscellaneous Devices: Install immediately adjacent to sensors, pressure gages, and thermometers.
- D. Tag: 1-1/2 inch round tag, 19 gage brass with 1/4 inch letters, labeled "TEST TAP". Attach with brass chain.

**3.10 PIPE ESCUTCHEONS**

- A. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings. Escutcheons not required where sleeves project above floor.

**3.11 COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

**3.12 HANGER ROD SCHEDULE**

ROD DIAMETER (INCH)	PIPE SIZE (INCH)	LOAD AT 650 F (POUNDS)
3/8	2 and smaller	730
1/2	2-1/2 and 3-1/2	1,350
5/8	4 and 5	2,160
3/4	6	3,230

**3.13 SPACING OF HANGERS AND SUPPORTS SCHEDULE**

PIPE SIZE (INCH)	STEEL AND IRON PIPE MAXIMUM SPAN (FEET)		COPPER TUBING MAXIMUM SPAN (FEET)	
	WATER SERVICES	STEAM, GAS, AND AIR SERVICES	WATER SERVICES	GAS AND AIR SERVICES
1/2 and smaller	7	8	5	6
3/4	7	9	5	7
1	7	9	6	8
1-1/4	7	9	7	9
1-1/2	9	12	8	10
2	10	13	8	11
2-1/2	11	14	9	13
3	12	15	10	14
4	14	17	12	16
6	17	21		

\*\*\*END OF SECTION\*\*\*

**SECTION 23 23 00**  
**REFRIGERANT PIPING SYSTEMS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes refrigerant piping and specialties.
- B. Contract Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.
  - 2. ASHRAE Standard 34, Designation and Safety Classification of Refrigerants.
  - 3. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - 4. ASME B31.5, Refrigeration Piping and Heat Transfer Components.
  - 5. ASTM B 280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
  - 6. AWS A5.8, Specification for Filler Metals for Brazing and Braze Welding.
  - 7. MSS SP- 58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
  - 8. MSS SP- 69, Pipe Hangers Supports – Selection and Application.
- C. Refrigeration Piping Subcontractor Qualifications: Company specializing in performing the work of this Section with minimum 5 years' experience.
- D. Refrigeration piping subcontractor shall size piping in accordance with refrigeration equipment manufacturer's recommendations and sizing requirements.
- E. Installer's Qualifications for Copper Press Fitting Couplings: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Refrigerant piping.
  - 2. Refrigerant.
  - 3. Flexible connectors.
  - 4. Shutoff valves.

5. Pipe supports.
  6. Blank copy of start-up and test report form.
- C. Qualifications: Submit documentation as defined under Paragraph "Refrigeration Piping Subcontractor Qualifications".
- D. Installer Qualification Data and Certificates of installers for Copper Press Fitting Couplings.
- E. Design Data: Basis of pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- F. Shop Drawings: Refrigeration piping plan and diagram indicating layout of system, including equipment, critical dimensions, and pipe sizes.
- G. Test Reports:
1. Testing and charging reports for each system.
  2. Field start-up and test reports.
  3. Include completed copy of reports in the Operations and Maintenance Manual.

## PART 2 - PRODUCTS

### 2.01 REFRIGERANT PIPING

- A. Pipe: Copper, Type ACR hard drawn, ASTM B 280, cleaned and dehydrated for refrigeration service with ends capped and sealed, 300 psig working pressure rating.
- B. Fittings: Wrought copper solder joint, ASME B16.22.
- C. Copper Press Fitting Couplings and Fittings:
1. Suitable for Type ACR hard drawn copper tubing for sizes 1/4 through 1-1/4 inch. Press-to-connect joint made with pressing tool and jaw sets recommended by fitting manufacturer.
  2. Refrigerant grade copper, UNS C12200 fittings with HNBR O-ring with three press points, one on each side of the bead and one press compressing the O-ring.
  3. Rated to maximum 700 psig working pressure for temperature range between minus 40 F to 250 F.
  4. Conex Banninger MaxiPro, Parker, or approved.
- D. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 F to 1480 F.

### 2.02 REFRIGERANT

- A. Description: Comply with ASHRAE Standard 34. Type as indicated on the Drawings.

### 2.03 FLEXIBLE CONNECTORS

- A. Description: Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inch long with copper tube ends. Maximum working pressure 500 psig.
- B. Manufacturers: Superior Valve Company, Parker Hannifin Corporation, Packless Industries, Anaconda Universal Associates, Inc., or approved.



#### 2.04 SHUTOFF VALVES

- A. Diaphragm Packless Valves: UL listed and labeled, globe design with straight-through or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating. Maximum working pressure 500 psig and maximum temperature 275 F.
- B. Ball Valves: Two piece bolted forged brass body with Teflon® ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals. Maximum working pressure 500 psig and maximum temperature 300 F.
- C. Service Valves: Forged brass body with copper stubs, brass caps, removable valve core, integral replaceable ball check valve, flared or solder ends. Maximum pressure 500 psig.
- D. Manufacturers: Superior Valve Company, Parker Hannifin Corporation, Henry Technologies, or approved.

#### 2.05 CHECK VALVES

- A. Description: Cast bronze valve body, globe style, forged brass bolted bonnet, solder ends, and Teflon® seat. Internal parts removeable. UL listed and labeled. Maximum working pressure 500 psig and temperature range of minus 20 F to 300 F. Bi-directional for heat pump applications.
- B. Manufacturers: Henry Technologies or approved.

#### 2.06 PIPE SUPPORTS

- A. Comply with requirements in Section 232116. In addition, furnish insulated pipe clamps, National Refrigeration Products (NRP) Insulclamps, Hydra-Zorb® Klo-Shure Insulation Couplings, Hydra-Zorb® Cushion Clamp Assemblies, Hydra-Zorb® Titan® Insulation Riser Clamp Series, Hydra-Zorb® Bronco® Support for Insulated Pipes, or approved.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

**3.04 MECHANICAL EQUIPMENT CONNECTION**

- A. Connect refrigerant piping to mechanical equipment as indicated on the Drawings. Comply with equipment manufacturer's installation instructions.

**3.05 PIPING INSTALLATION**

- A. Install pipe supports in accordance with MSS SP-58, MSS SP-69, and Section 232116, whichever is more stringent.
- B. Installation:
  - 1. Ream pipe and tube ends. Remove burrs.
  - 2. Take care to keep piping clean and dry. Wet tubing not acceptable.
  - 3. Remove scale and dirt on inside and outside before assembly.
  - 4. Prepare piping connections to equipment with flanges, unions, or flared connections.
  - 5. Install piping to prevent liquid refrigerant from entering compressor. Slope horizontal suction piping toward compressor. Slope horizontal hot gas discharge piping downward away from compressor.
  - 6. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment and to prevent compressor piping vibration being transmitted to building construction.
  - 7. Provide clearance for installation of insulation and access to valves and fittings.
  - 8. Flood piping system with nitrogen when brazing.
  - 9. Install refrigeration specialties factory furnished with equipment specified in Section 238100.
- C. Oil Return:
  - 1. Arrange piping to return oil to compressor.
  - 2. Install traps, loops, and double risers in piping as required by refrigeration equipment manufacturer.
  - 3. Slope horizontal piping at 0.40 percent in direction of flow.
- D. Flexible Connectors: Install at connections to heat pumps, fan coil units specified in Section 238100.

**3.06 COPPER PRESS FITTING COUPLINGS**

- A. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

**3.07 TESTING AND CHARGING**

A. Testing:

1. Test refrigeration system in accordance with ASME B31.5.
2. Pressure test system with dry nitrogen to 250 psig.
3. Perform final tests at 27 inch vacuum and 375 psig using halide torch or electronic leak detector.
4. Test to no leakage. If leakage occurs, repair and retest until leakage is zero.

B. Evacuating and Charging:

1. Install cartridge in replaceable cartridge type filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Perform evacuation in the presence of the Owner's representative. Notify Owner's Representative at least 72 hours before expected test.
5. Fully charge completed system with refrigerant after testing.
6. Follow ASHRAE Standard 15 procedures for charging and purging of systems and for disposal of refrigerant.

**3.08 HVAC SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

**3.09 COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 31 00**  
**AIR DISTRIBUTION**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes sheet metal work and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASTM A 480, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
  - 2. ASTM A 653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - 3. ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  - 4. ASTM C 177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
  - 5. ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - 6. ASTM C 518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - 7. ASTM C 916, Standard Specification for Adhesives for Duct Thermal Insulation.
  - 8. ASTM C 1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
  - 9. ASTM C 1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
  - 10. ASTM C 1534, Standard Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems.
  - 11. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 12. ASTM G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
  - 13. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - 14. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
  - 15. SMACNA HVAC Air Duct Leakage Test Manual, (SMACNA Leakage).
  - 16. SMACNA HVAC Duct Construction Standards, Metal and Flexible (SMACNA).
  - 17. SMACNA Rectangular Industrial Construction Standards, (SMACNA Rectangular).
  - 18. SMACNA Round Industrial Construction Standards, (SMACNA Round).
  - 19. UL 181, Standard for Factory-Made Air Ducts and Air Connectors.

20. UL 181B, Standard for Closure System for Use with Flexible Air Ducts and Air Connectors.
21. UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.
22. UL 1381, Outline of Investigation for Aerosol Duct Sealant.

C. Duct Cleanliness Requirements:

1. Prevent damage to ducts during transportation and off-loading. Deliver only when ducts can be stored under permanent cover. Plastic tarp covering of ducts on jobsite not acceptable.
2. Keep site storage areas clean and dry with minimal exposure to dust.
3. Keep working area clean and dry and protected from weather elements.
4. Prior to installation of individual duct sections, inspect to ensure they are free from debris and wipe internal metal surfaces.
5. Cover duct risers to prevent entry of debris.
6. Cover open ends of ducts and downward facing and horizontal duct openings.
7. If, in the opinion of the A/E, ducts and fittings are not kept clean or completely dry, replace ducts and fittings or clean interior of affected ducts and fittings to satisfaction of the A/E at no additional cost to the Owner.

1.03 **SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  1. Sheet metal work, general.
  2. Sheet metal work, miscellaneous.
  3. Four-bolt or corner-clip duct connection system.
  4. Flexible ducts.
  5. Duct soundlining, non-fiberglass.
  6. Fasteners.
  7. Hangers for sheet metal work.
  8. Drain pans.
  9. Miscellaneous duct accessories.
  10. Blank copy of start-up test and report form.
- C. Shop Drawings: Comply with requirements in Section 230500.
- D. Test Reports:
  1. Test apparatus calibration certificate for duct leakage testing.
  2. Pressure testing for leakage.
  3. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

1.04 **WARRANTY**

- A. Aerosol-Based Sealing Method: Warrant aerosol sealant application for 3 years after Substantial Completion date. Warranty shall cover material, labor, and travel time. Make available repairs within 48 hours of initial notification.

1.05 **PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION**

- A. Section 230548 – Vibration Isolation: Flexible connectors.
- B. Section 283111 – Fire Alarm and Detection Systems: Duct smoke detectors.

PART 2 - PRODUCTS

2.01 **SHEET METAL WORK, GENERAL**

- A. Duct Construction:
  - 1. Comply with SMACNA. Standing seams not acceptable for exposed ducts.
  - 2. Galvanized steel in general with G-90 zinc coating, ASTM A 653, minimum 26 gage.
  - 3. Galvanized steel prepped or ducts finished with Paint Grip for field painting where exposed in finished spaces as scheduled in Division 09.
- B. Pressure Classifications:
  - 1. Ducts between Variable Air Volume (VAV) Heat Recovery Units and VAV Terminal Units: 6 inch w.g.
  - 2. Ducts downstream of VAV and Fan Powered Terminal Units: 2 inch w.g.
  - 3. Return and Exhaust Ducts: Plus 2 inch downstream of fans and minus 2 inch w.g. upstream of fans for fan design static pressure scheduled on the Drawings at 1.0 inch w.g. and above.
  - 4. Return, Relief, and Exhaust Ducts: Plus 1 inch downstream of fans and minus 1 inch w.g. upstream of fans for fan design static pressure scheduled on the Drawings at less than 1.0 inch w.g. Plus 1 inch w.g. for relief ducts.
  - 5. Supply Ducts not Listed Above: 2 inch w.g.
  - 6. Transfer Ducts: 0.5 inch w.g.
- C. Round Ducts: Spiral seam with beaded sleeve at transverse joints.
- D. Fittings:
  - 1. Comply with SMACNA as follows:
    - a. Round Elbows: Full radius ( $R/D=1.5$ ), spiral seam for 6 inch w.g. ducts and 5 piece segmented or stamped for 2 inch w.g. ducts. Adjustable elbows not acceptable.
    - b. Rectangular Elbows: Full radius ( $R/W=1.5$ ) where minimum 5 duct widths is available downstream of elbow fitting prior to branch take off. If straight length not available, use square throat elbow with turning vanes.
    - c. Round Tees and Laterals: Conical fitting or tap per SMACNA Figure 3-6, 90 degree tee with oval to round tap, 45 degree lateral fitting, tap, or saddle tap, or 45 degree rectangular lead-in per SMACNA Figure 3-5. 90 degree tee not acceptable. Saddle tap connections for exposed ducts in finished spaces not acceptable.
    - d. Spin-in Fittings: Conical type, with volume damper, quadrant, and accessories for 2 inch w.g. ducts. Include closed outside end bearing, insulation guard for installation in duct with soundlining, and standoff bracket for installation in duct with insulation.
    - e. Rectangular Laterals: 45 degree entry fittings per SMACNA Figure 4-6.

- f. Offsets: Full radius ( $R/D=1.5$  for round and  $R/W=1.5$  for rectangular) where space allows. Mitered offset (Type 2) with 30 degree maximum offset angle per SMACNA Figure 4-7. Angle offset (Type 1) not acceptable.
  - g. Divided flow fittings acceptable per SMACNA Figure 4-5 for rectangular ducts except for branch connections to outlets and inlets.
- 2. Bellmouth Fittings: 18 gage spun sheet metal, formed into uniform radius bellmouth. Minimum radius of bell equal to 0.2 times neck diameter.
  - 3. Screened Openings: 1/2 inch mesh screen, 14 gage galvanized steel wire. Enclose mesh screen with 20 gage galvanized removable sheet metal frame around perimeter.
  - 4. Duct Collars: 2 inch wide galvanized steel for galvanized ducts, aluminum for aluminum ducts 20 gage. Mitered corners for square and rectangular ducts. Escutcheon type for round and flat oval ducts.
- E. Turning Vanes:
- 1. Description: Airfoil design, smoothly-rounded entry nose, extended trailing edge, continuous internal tubes for stiffening and rigidity of section, adaptable to duct sizes. Maximum generated sound power level 54 decibels in octave band 4 at 2000 fpm velocity in 24 inch by 24 inch duct size.
  - 2. Assembly Fabrication: Side rails by same manufacturer as turning vanes. Vanes installed on 2.4 inch centers across full diagonal dimension of elbow per SMACNA Figure 4-3. Rail systems with non-standard tab spacing not acceptable.
  - 3. Unequal Elbows: Fabricate and adjust to set vanes in assembly at correct angle of attack, resulting in leading and trailing edges in parallel to duct surfaces.
  - 4. Manufacturer: H.E.P. - High Efficiency Profile - as manufactured by Aero Dyne Co. (1-800-522-2423) or approved.
  - 5. At Contractor's option, double wall turning vanes fabricated from same material as adjacent duct acceptable. Include mounting rails with friction insert tabs that align vanes automatically.
- F. Acoustical Turning Vanes:
- 1. Double wall, perforated, glass fiber fill, polyester liner.
  - 2. Manufacturer: Ductmate Industries Inc. or approved.
- G. Soundlined Ducts: Fabricate with duct soundlining such that no gap will result between sections of duct lining after assembly of duct sections. Fabrication and installation shall result in adjacent soundlining sections butted together without gaps, bulges, or other discontinuities.
- H. Duct Sealant, Traditional Method (Contractor Option)
- 1. Indoor Locations: UL 181 listed and labeled. Low odor, non-toxic vapors, surface burning characteristics for maximum flame spread of 25 and maximum smoke developed of 50 when in a dry state. Rated for air temperature range of minus 20 F to plus 150 F. Rated to 10 inch w.g., minimum 65 percent solid content. Foster® 32-19™ Duct-Fas, Childers CP-146 Chil-Flex™, McGill AirSeal LLC, United Duct Sealer™ (Water Based), Biddle Aqua-Crylic HVAC, Hardcast Iron-Grip 601, Design Polymerics DP1010, Ductmate Industries Inc. PROseal<sup>EZ</sup> or EZseal™, or approved.

- I. Aerosol-Based Sealing Method (Contractor Option): Application performed by manufacturer trained and approved service provider. Sealant cured within 2 hours of application with no VOC off-gassing and remain elastic, UL 1381 listed. Mastic and fiberglass mesh tape used for repairing leaks UL 181 listed and labeled. AeroSeal, LLC, or approved.

## 2.02 SHEET METAL WORK, MISCELLANEOUS

- A. Exhaust Ducts Serving Locker Rooms, Showers, Pools, Spas, and Similar Wet Areas: Aluminum, ASTM B 209, same gage as specified in Article "Sheet Metal, General" in this section.
- B. Clothes Dryer Vent Duct:
  1. Flexible Duct: Aluminum. UL listed and labeled. Foil flexible, plastic, or vinyl hose not acceptable.
  2. Rigid Duct: Type 304 stainless steel, ASTM A 480, minimum 24 gage with no fasteners protruding into duct.
- C. Type II Hood Exhaust Ducts:
  1. General: Type 304 stainless steel, ASTM A 480, minimum 18 gage, continuously welded seams and joints for steam and water tightness.
  2. Exposed: Polished, finish same as for hoods specified in Division 11.
- D. Vehicle Exhaust Ducts:
  1. General: Minimum 16 gage galvanized steel, welded seams and joints, fabricated in accordance with SMACNA Round and SMACNA Rectangular.
  2. Fittings: Factory fabricated, McGill AirFlow LLC, AccuDuct Manufacturing Inc., or approved.
  3. Flanges: Continuously welded to duct and bolted to mating surface with stainless steel bolts and nuts and 1/8 inch thick resilient PVC full face gasket between flanges.

## 2.03 FOUR-BOLT OR CORNER-CLIP DUCT CONNECTION SYSTEM

- A. General: System used for rectangular sheet metal work at Contractor's option.
- B. Components: Roll-formed 20 gage galvanized steel flanges with integral mastic sealer, embossed corner pieces, UL listed and labeled, metal cleats, duct sealer, closed cell neoprene gaskets, and cadmium plated bolts and nuts.
- C. Lined Ducts: Fabricate with no gaps, bulges, or other discontinuities between adjacent sections of duct lining after assembly.
- D. Manufacturers: Ductmate Industries Inc, Nexus™, Ward Industries, or approved. Fabricate in strict conformance to manufacturer's instruction.



## 2.04 FLEXIBLE DUCTS

- A. Description: Factory-insulated with low permeability vapor barrier jacket constructed of reinforced metalized laminate film, suitable for medium and low pressure applications, 1 inch thick fiber glass insulation, coated steel spring helix reinforcement bonded to chlorinated polyethylene liner.
1. Ratings: UL 181 listed and labeled as a Class 1 flexible duct with maximum flame spread rating 25, maximum smoke-developed rating 50.
  2. Length: Assemblies in 5 foot length with galvanized male and female fittings attached to liner and vapor barrier jacket acceptable.
- B. Manufacturers: Thermaflex<sup>flex</sup> MK-E, Wiremold 57K, Flexmaster U.S.A.® 8m, or approved.

## 2.05 DUCT SOUNDLINING, NON-FIBERGLASS

- A. Description: Non-fiberglass acoustical and thermal insulation, 1 inch thick unless noted otherwise on the Drawings.
- B. Standards and Ratings: ASTM C 1534, NFPA 90A, and NFPA 90B, and UL 181 for preformed duct coverings and linings. K-value 0.25 Btu/hr/sq ft/F at 75 F mean temperature per ASTM C 177 or ASTM C 518.
- C. Composition:
1. Fiber-free, formaldehyde-free, low VOCs, non-particulating, closed cell structure with Microban® antimicrobial product protection per ASTM G 21 and ASTM C 1338. Composite surface burning characteristics for maximum flame spread of 25 and maximum smoke developed of 50 per ASTM E 84, NFPA 255, and UL 723. Type I closed cell EPDM elastomeric duct soundlining acceptable.
  2. Temperature limit 180 F per ASTM C 411.
  3. Velocity rated for erosion resistance to 10,000 fpm per ASTM C 1071.
- D. Duct Soundlining Adhesive: Pressure sensitive adhesive system for non-pinned field applications. ASTM C 916.
- E. Manufacturers: Armacell® AP Armaflex® SA Duct Liner for 1 inch thickness, Armacell® AP Armaflex® FS SA Duct Liner for 1-1/2 and 2 inch thicknesses, Armacell® AP Spiraflex Spiral Duct Liner for 1 inch thickness, Armacell® AP Coilflex™ Duct Liner for 1 inch thickness, Ductmate Industries Inc. PolyArmor™, Aeroflex USA, Inc. Aerocel AC, or approved.

## 2.06 FASTENERS

- A. Description: Use blind rivets, sheet metal screws, or bolted connections where required by SMACNA for attachment purposes for sheet metal. Sheet metal screws and rivets minimum length required for secure fastening. Where rivets are specifically called for in this section, sheet metal screws may be used.
- B. Locations: For ducts, grilles, and accessories exposed to view in finished rooms, include finish-type fasteners.
1. Permanent Work: Blind stainless steel pop rivets.
  2. Removable Items and Grilles: Cadmium-plated pan head or countersunk tapping screws.

**2.07 HANGERS FOR SHEET METAL WORK**

- A. Description: Hangers, supports, and anchor bolts for sheet metal work and equipment, same material as for duct construction.
- B. Building Attachments: Concrete inserts and structural-steel fasteners appropriate for construction materials to which hangers are being attached. Comply with requirements in Section 230510.
- C. Duct Sizes: Refer to maximum cross-section dimension at location of hangers.
- D. Horizontal Rectangular and Round Ducts: Comply with SMACNA. Wire hangers not acceptable.
- E. Vertical Ducts: Angles attached to sides in pairs. Comply with SMACNA. In shafts, include supplementary steel angles, formed steel channels, or saddles at each floor to distribute loads from bracing angles, channels, or saddles to the structure.

**2.08 DRAIN PANS**

- A. For Air Conditioning Units: 18 gage galvanized steel, seams and joints continuous welded watertight, bottom double sloped to drain connection. Fabricate per SMACNA with 2 inch high sides.

**2.09 MISCELLANEOUS DUCT ACCESSORIES**

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

**PART 3 - EXECUTION**

**3.01 INSPECTION**

- A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance", provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

- B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

### 3.04 DUCT INSTALLATION

A. General:

1. Install in workmanlike manner. Fabrications, fittings, joints, take-offs, attachments, turning vanes, dampers, and sealing in accordance with requirements of SMACNA as specified in this section and as indicated on the Drawings. If used as part of duct fabrication process, install duct labels on outside of ductwork. Installation of duct labels on inside of duct not acceptable.
2. Comply with requirements in Section 230548 for seismic restraints of ducts and for penetrations through mechanical room walls and floors and acoustical walls.
3. Hang ducts from roof structure and not from the roof deck itself. Provide formed steel channels or supplementary steel framing as specified in Section 230510 to span between roof structural members.
4. Locate ducts with sufficient clearance around equipment to allow for inspection, repair, replacement, and service.
5. Cap incomplete duct ends with temporary closures of taped polyethylene to prevent construction dust from entering ducts.
6. Install duct collars where exposed ducts pass through non-fire rated walls and ceilings. Fasten tight to ducts.
7. Duct sizes may be changed as long as the new dimensions are equivalent to those indicated and do not exceed 4 to 1 aspect ratio.
8. Transitions:
  - a. Fabricate and install duct transitions for connections to equipment, such as fans, coils, smoke dampers, motor operated dampers, VAV units, and where the connection sizes are different from duct sizes indicated on the Drawings.
  - b. Where transitions are required to fit into available space, fabricate to maintain equivalent free area of duct sizes with angle less than 15 degrees.
9. Drawings do not show offsets which may be required. Make offsets with fittings with as small an angle of offset as possible. Install turning vanes in square corner elbows.
10. Install acoustical turning vanes in return air square throat elbows.
11. Install flanged connections to equipment with neoprene gaskets.
12. Install ducts through roof to be watertight. Coordinate with any details on the Drawings as to flashings and curbs.
13. Install straight sheet metal duct at inlet VAV units, 2 foot or 3 equivalent duct diameters long, whichever is longer, size equal to unit inlet connection. Include transition at upstream end of straight duct if primary duct size is larger than unit inlet connection.
14. Install straight sheet metal duct at outlet of VAV units, size to match unit outlet connection or minimum size per schedule on the Drawings with transition from outlet connection size. Install branch connections minimum 4 foot from unit outlet.
15. Install ducts within shafts without contact with walls.
16. Install ducts, unless otherwise indicated on the Drawings, vertically and horizontally and parallel and perpendicular to building lines.
17. Install test holes at fan inlets and outlets and elsewhere as indicated on the Drawings. Locate where required for testing and balancing purposes as directed by the TAB subcontractor specified in Section 230593.
18. Install return air and transfer air openings above ceilings with minimum 2' - 0" clearance to obstructions.

- B. Clothes Dryer Vent Duct: Install flexible duct between appliance connection and rigid duct. Install with stainless steel worm drive hose clamp on both ends. Eight foot maximum length, fully extended. Install male end of rigid duct in direction of airflow. Install cleanouts for vertical risers.
- C. Type II Hood Exhaust Ducts: Slope horizontal ducts at 1/2 inch per lineal foot back to hood.
- D. Flexible Connectors:
1. Install flexible connectors furnished under Section 230548 at connections to vibration-isolated (spring and rubber isolator-mounted) fans, packaged HVAC equipment, externally isolated air handling units, fan coil units, and similar equipment. Internally isolated equipment does not require flexible connectors.
  2. Support duct on both sides of flexible connector to ensure alignment and to avoid binding connector.
  3. Install with sufficient slack to permit 2 inch horizontal or vertical movement without stretching fabric and to efficiently isolate vibration of fans from ducts.
  4. Install equipment without flexible connectors in corridor ceiling spaces where fire rating is required.
- E. Duct and Plenum Sealing, Traditional Method (Contractor Option): SMACNA Seal Class A. Apply duct sealer to transverse joints, longitudinal seams, fitting connections, corners of four-bolt or corner clip duct connection system, and fitting seams except continuous welded type. Spiral seams, continuous welded seams, and transverse joints for 4-bolt or corner clip duct connection system are not required to be sealed unless visible and audible leaks exist or duct leakage exceeds that allowed by leakage test specified in this section. Comply with manufacturer's recommendations.
- F. Duct Sealing, Aerosol-Based Sealing Method (Contractor Option):
1. Preparation:
    - a. Inspect air distribution systems for leakage sites and accumulation of dust and debris. Remove debris and dust and dirt greater than 1/8 inch thick.
    - b. Coordinate with other subcontractors to temporarily remove or protect control devices and fire and smoke detectors from aerosol particles as required by aerosol manufacturer.
    - c. Temporarily disable fire alarm devices and notify the AHJ.
    - d. Temporarily isolate air distribution equipment and cover air devices and similar items as required by aerosol manufacturer.
    - e. Protect occupied spaces from aerosol particles.
  2. Duct Sealing:
    - a. Repair major leakage locations greater than 1/2 inch wide using mastic and fiberglass mesh tape per SMACNA.
    - b. Seal ducts internally using automated aerosolized sealant injection.
    - c. Prepare pre-sealing, post-sealing, and sealing profile reports for duct sections sealed.
    - d. Repair injection and test holes per SMACNA.
  3. Duct Testing: Comply with requirements in Article "Pressure Testing for Leakage" in this section

4. Duct Re-assembly and Cleanup:
  - a. Coordinate with other subcontractors to reinstall control devices and fire and smoke detectors.
  - b. Coordinate with other subcontractors to enable fire alarm devices and notify the AHJ.
  - c. Remove isolation for air distribution equipment and remove covers from air devices and similar items and enable air distribution equipment.
  - d. Cleanup sealant residue from surfaces in occupied spaces.

### 3.05 FLEXIBLE DUCTS

- A. Install per SMACNA Figures 3-10 and 3-11 except as noted below.
- B. Connect to metal ducts with slip joint made using fire-resistant mastic and stainless steel or plastic machine-applied clamp. Cloth tape adhesive and duct tape not acceptable.
- C. Five foot maximum length, fully extended. Generally install with straight sections, without bends. If bends are required, install with maximum one-90 degree bend, R/D=2.5 or greater. No kinks allowed. Sheet metal elbows to result in straight flexible duct runs acceptable.
- D. Hang flexible duct on 5' - 0" centers and at 90 degree bend with 1 inch wide flat steel strap to span at least 3 spiral wires. Maximum 1/2 inch sag per foot. Support shall not cause out-of-round shape.
- E. Installation in corridor ceiling spaces where fire rating is required not allowed.

### 3.06 DUCT SOUNDLINING, NON-FIBERGLASS

- A. General: Install duct soundlining per manufacturer's requirements. Install sheet metal nosings at leading edge of lining when air stream velocity exceeds 4,000 fpm. Duct dimensions indicated on the Drawings are net inside dimensions. Increase sheet metal dimensions to accommodate duct soundlining thickness.
- B. Extent:
  1. Supply, return, and exhaust air ducts where indicated on Contract Drawings.
  2. Grille and diffuser boxes and boots.
  3. Transfer ducts.
- C. Transportation and Handling:
  1. Transport and handle in accordance with manufacturer's instructions.
  2. Promptly inspect shipments to ensure that materials comply with requirements and are undamaged.
  3. Provide equipment and personnel to handle materials by methods to prevent soiling, disfigurement, or damage.
  4. Clean sheet metal surfaces prior to duct lining application per manufacturer's instructions.
- D. Storage and Protection:
  1. Store and protect in accordance with manufacturers' instructions.
  2. Store with seals and labels intact and legible.

3. Store in weathertight, climate controlled enclosures in an environment favorable to materials.
  4. Exterior storage not acceptable.
  5. Use off-site storage and protection when site does not permit on-site storage or protection.
  6. Use equipment and personnel to store materials by methods to prevent soiling, disfigurement, or damage.
  7. Arrange storage of materials to permit access for inspection. Periodically inspect to verify materials are undamaged and are maintained in acceptable condition.
  8. Avoid installation of soundlined duct in exterior conditions (prior to enclosure of building exterior envelope). If it is absolutely necessary to install soundlined duct prior to building enclosure, provide temporary enclosures with impervious sheet covering arranged to shed water, anchored securely against the wind. Ventilate building to prevent condensation and degradation of materials.
- E. Protection of Installed Work:
1. Provide temporary and removable protection for installed soundlining. Use durable sheet materials.
  2. Control activity in immediate work area to prevent damage.
  3. Install protective coverings at openings.
  4. Prohibit traffic or storage upon installed surfaces.
- F. Installation: For soundlined ducts, use care during installation to insure that soundlining remains clean and dry, and that no gap will result between sections of duct soundlining after assembly of duct sections. For multi-layer applications, stagger seams. Installation shall result in adjacent soundlined sections butted together without gaps, bulges, or other discontinuities. Ensure that mating edges are sealed in the field.

### 3.07 DUCT SMOKE DETECTORS

- A. Coordinate location requirements with Division 28 work prior to preparing and submitting sheet metal Shop Drawings to comply with detector manufacturer's installation requirements. Install duct smoke detectors furnished by electrical subcontractor.

### 3.08 PRESSURE TESTING FOR LEAKAGE

- A. Description: Test medium pressure (3 inch w.g. and greater) ductwork systems. Test random sampling of 10 percent of low pressure (2 inch w.g. and less) ductwork systems as selected by the A/E. If tests achieve leakage rates in accordance with requirements of this section, remainder of systems do not need to be tested. If any test fails to meet requirements of this section, test low pressure (2 inch w.g. and less) duct systems in their entireties.
- B. Test Standard: SMACNA Leakage.
- C. Leakage Class (CL) is defined as  $CL = F/P^{0.65}$  where:
1. F is leakage rate in cfm per 100 sq. ft of ductwork surface area.
  2. P is static pressure at which test is conducted and duct construction class as specified in this section.

Duct Construction Class (Pressure Classification)	Leakage Class (CL)
1/2 inch w.g.	16

1 inch w.g.	16
2 inch w.g.	8
3 inch w.g.	4
4 inch w.g.	4
6 inch w.g.	2
10 inch w.g.	2

- D. Test Apparatus: Portable blower with volume adjustment, flow measuring assembly for determining cfm of air being added to duct consisting of calibrated orifice mounted in straight tube with straightening vane and pressure taps, U-tube manometer, and calibration curve for orifice assembly. Submit test apparatus calibration certificate.
- E. Test Procedures:
1. Test duct before insulation is installed.
  2. Close off and seal openings in duct section to be tested. Connect test apparatus to duct by means of flexible duct.
  3. Test for audible leaks as follows:
    - a. Start blower with its control damper closed.
    - b. Gradually open control damper until duct pressure reaches specified pressure classification.
    - c. Survey joints and seams for audible leaks. Mark each leak and repair after shutting down blower. Do not retest until sealants have set.
  4. After audible leaks have been sealed, retest. Seal and retest as necessary until maximum leakage is less than allowable amount as determined by defined leakage class as specified in this section.
  5. Submit duct section data, calculations, and test results for each duct section.
  6. Summation of leakage for sections shall not exceed total allowable system leakage. Base allowable leakage on total surface square footage of installed duct.
  7. Test of each duct section may be witnessed by the A/E. Give at least 7 calendar days prior notice before such tests.

### 3.09 HVAC SYSTEMS TRAINING

- A. Comply with requirements in Section 230810.

### 3.10 COMMISSIONING

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 33 00**  
**AIR DISTRIBUTION ACCESSORIES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes accessories for air distribution systems and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. AMCA 500-D, Laboratory Methods of Testing Dampers for Rating.
  - 2. AMCA 511, Certified Ratings Program – Product Rating Manual for Air Control Devices.
  - 3. ARI 885, Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
  - 4. ASTM C 1071, Standard Specification for Fibrous Duct Lining Insulation (Thermal and Sound Absorbing Material).
  - 5. NFPA 80, Standard for Fire Doors and Other Opening Protectives.
  - 6. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - 7. NFPA 105, Standard for Smoke Door Assemblies and Other Opening Protectives.
  - 8. SMACNA Fire, Smoke and Radiation Damper Installation Guide.
  - 9. SMACNA HVAC Duct Construction Standards, Metal and Flexible (SMACNA), Third Edition, 2005.
  - 10. UL 181, Factory-Made Air Ducts and Air Connectors.
  - 11. UL 555S, Smoke Dampers.
  - 12. UL 1995, Heating and Cooling Equipment.
  - 13. UL 1996, Electric Duct Heaters.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Volume dampers and quadrants.
  - 2. Automatic balancing dampers.
  - 3. Smoke dampers including installation instructions.
  - 4. Access doors and frames.
  - 5. Variable air volume (VAV) units.
  - 6. Electric duct heaters, proportional controlled.



7. Clothes dryer vent components.
  8. Blank copy of start-up and test report forms.
- C. Shop Drawings: Comply with requirements in Section 230500.
- D. Test Reports:
1. Fire Damper Log: Prior to air handling system startup, submit fire damper log. Log shall consist of an Excel spreadsheet listing each smoke damper location, size, electrical connection information and date tested. Include additional comments for miscellaneous information.
  2. Factory test reports for duct silencers (sound traps).
  3. Submit completed copy of reports and include copy in the Operations and Maintenance Manual.

**1.04 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION**

- A. Section 230900 – Automatic Temperature Controls: Motorized dampers and air terminal unit controllers and actuators.
- B. Section 234100 – Filters: Duct mounted filter housings and filters during construction.

**1.05 PRE-INSTALLATION MEETING**

- A. Prior to installing smoke dampers sheet metal subcontractor shall arrange for and conduct a pre-installation meeting to review installation requirements. Meeting participants shall include at a minimum representatives from the general contractor, sheet metal, electrical and fire alarm subcontractors, AHJ, the A/E, mechanical engineer, and the Owner.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Comply with SMACNA.

**2.02 VOLUME DAMPERS AND QUADRANTS**

- A. Factory Built Adjustable Dampers (Use for rectangular ductwork):
1. Description: Single or multiple blades, steel construction meeting SMACNA Standards for construction requirements for volume dampers.
  2. Ratings and Standards: Maximum 4 inch w.g. pressure differential, 2000 fpm velocity and 180 F. Testing and ratings per AMCA 500-D.
  3. Construction: Galvanized steel, 20 gage hat channel frame and 16 gage reinforced blades, linkage concealed in jamb, 1/2 inch diameter plated steel axles and control shaft, and synthetic sleeve type bearings.
  4. Manufacturers: Greenheck Fan Corp. Model MBD-15, Air Balance, Inc., Ruskin Company, Pottorff or approved.
- B. Factory Built Adjustable Dampers (Use for round ductwork up to 14 inch diameter):
1. Description: Single round blade with end bearing and flat handle, designed for medium and high pressure systems.

2. Construction: Galvanized steel, 20 gage blade with formed channel for 3/8 inch square rod, snap lock bearing with O-ring and retaining ring, triple function handle with bearing end damper blade holder, and standoff bracket for ducts with external insulation, height to accommodate insulation thickness specified in Section 230700.
  3. Manufacturer: Rossi HVAC Hardware or approved.
- C. Quadrants Where Ducts are Accessible:
1. Description: Handle regulator set with hex nut and acorn nut. Full length shaft, sizes meeting SMACNA Standards for damper blade sizes. Include closed end cast alloy bearing and standoff bracket for ducts with external insulation, height to accommodate insulation thickness specified in Section 230700.
  2. Manufacturers: Duro Dyne Corp., Young Regulator Company, Ventfabrics, Inc., or approved.
- D. Quadrants Where Ducts are Not Accessible:
1. Description: Concealed style regulator set with hex nut, cast alloy corrosion resistive plated cover, couplings, and 90 degree angle drive die cast miter gear assembly for round or square damper rod. Cover prime painted.
  2. Manufacturers: Duro Dyne Corp., Ventfabrics, Inc., Young Regulator Company, or approved.

### 2.03 AUTOMATIC BALANCING DAMPERS

- A. Description: Circular volume flow controllers for constant and variable air volume systems with low airflow velocities, mechanical self-powered, without external power supply, suitable for supply or exhaust air. Ready-to-commission unit consists of the casing containing a damper blade with low-friction bearings, bellows, leaf spring, and a rotary knob to set the volume flow rate setpoint.
- B. Construction:
1. Inlet suitable for circular ducts to ANSI/SMACNA 006-2006 and EN 1506 or EN 13180.
  2. Casing air leakage to EN 1751, class C.
  3. Volume flow rate can be set using an external scale; no tools required
  4. Simple retrofit of an actuator is possible
  5. Correct operation even under unfavorable upstream or downstream conditions (1.5 D straight section required upstream)
  6. Any installation orientation
  7. Aerodynamic function testing of each unit on a special test rig prior to shipping
  8. Casing in galvanized sheet steel
  9. Damper blade and other parts made of metal or plastic to UL 94, V1; to DIN 4102, material classification B2
  10. Leaf spring made of stainless steel
  11. Polyurethane bellows
- C. Technical data:
1. Nominal sizes: 4 - 10 in
  2. Volume flow rate range: 13 - 775 CFM
  3. Volume flow rate control range: approx. 10 - 100 % of the nominal volume flow rate
  4. Volume flow rate accuracy: approx.  $\pm 10$  % of the nominal volume flow rate

- 5. Minimum differential pressure: 0.12 in w.g. (30 Pa)
  - 6. Maximum differential pressure: 2 in (500 Pa)
- D. Manufacturer: Trox VFC, Aldes MR MAX, Young Regulator CVD or approved.

#### 2.04 SMOKE DAMPERS

- A. Description: Smoke dampers, each with frame, sleeve, airfoil blades, and actuator for wall, floor, and ceiling installations, 250 F. Comply with SMACNA.
- B. Classification: UL 555S, NFPA 90A, Leakage Class 1. UL listed and labeled for dynamic systems with airflow in either direction. Include label indicating maximum allowable air quantity of 11 cfm/sq ft at 8 inch w.g. for fan driven air flow installations and 8 cfm/sq ft at 4 inch w.g. for relief and transfer air installations. 1-1/2 hour fire rated in general. Refer to Architectural drawings for fire ratings of general construction.
- C. Performance Rating: AMCA listed and labeled meeting AMCA 511 certifying air performance and air leakage performance.
- D. Size: Free area inside sleeves and within damper stop minimum 90 percent of area of connecting duct. Provide larger damper size to maintain 90 percent free area. Increase size of damper if duct sizes indicated on the Drawings are smaller than manufacturer's available sizes.
- E. Blades: Airfoil type, double skin, 6 inch maximum width. Single airfoil shaped blade for blade width extensions.
- F. Blade Position Assembly: Factory installed and tested assembly to permit remote damper operation after initial closure. Include blade damper indicator switch with remote indication.
- G. Sleeves: Galvanized steel, gage as required to meet manufacturer's installation instructions, factory mounted to damper with sealant between sleeve and damper.
- H. Actuator: Factory installed, electric, 120 V, 60 cycle, 1 phase, actuator and linkage mounted out of air stream, normally closed (damper closes when power is interrupted). Actuator "clamped" to shaft (slide-on installation not acceptable). Electric actuators with 5 year warranty, microprocessor based controller with electronic cutoff at full open, incapable of burning out if stalled before full rotation is reached, maximum 0.23 Amp when running and 0.1 Amp at full open, and auxiliary switch. Belimo Aircontrols (USA), Inc. FSNF120-US Series. No substitutions. Include monitoring of blade damper position to DDC system specified in Section 230900. Coordinate with controls subcontractor specified in Section 230900 to review and confirm configuration of actuator location. Do not order damper and actuator until documentation has been received.
- I. Manufacturers: Ruskin Company Model SD60, Air Balance, Inc., Nailor Industries, Inc., Pottorff, or Greenheck Fan Corp.

#### 2.05 ACCESS DOORS AND FRAMES

- A. General: Include access doors wherever access to ducts is necessary for reaching equipment. Double construction, hemmed edges (no sharp edges), tight fitting with gasket, hinged, with latch, and insulation or soundlining equivalent to that of adjacent duct. Steel angle frame. Access panels with sheet metal fasteners not acceptable.

- B. Access Door Sizes:
1. One-Hand or Inspection Access: 8 inch by 5 inch.
  2. Two-Hand Access: 12 inch by 6 inch.
  3. Head and Hand Access: 18 inch by 10 inch.
  4. Head and Shoulders Access: 21 inch by 14 inch.
  5. Body Access: 25 inch by 14 inch.
  6. Body plus Ladder Access: 25 inch by 17 inch.
- C. Latches: Die-cast, Ventfabrics, Inc. No. 100 for doors 2' - 0" high and smaller. Cat. No. 260 for doors up to 3' - 0" high. Cat. No. 310 for doors higher than 3' - 0". Use 2 for each door. Cam latches acceptable.
- D. For Medium Pressure Rectangular and Round Ducts for Access to Smoke Dampers: Combination access and pressure relief type or sandwich type with latches, retaining chain, and handle. Round or rectangular door to suit installation and access requirements. Access doors per manufacturer's standard sizes with maximum possible size for duct dimensions. Solid metal construction except insulated type where duct is insulated or constructed with duct soundlining. McGill AirFlow LLC, Ductmate Industries Inc, or approved.

## 2.06 VARIABLE AIR VOLUME (VAV) UNITS

- A. Description: Pressure independent, VAV units used to regulate airflow and/or heat to zone in response to zone temperature requirements.
- B. Agency Listings: UL listed and labeled or ETL. Certified under ARI 880 Certification Program. Include ARI seal. Sound performance certified in accordance with ARI 885.
- C. Construction - General:
1. Casing: Minimum 22 gage galvanized steel, height as required to fit in available space. Maximum leakage 10 cfm at 1.0 inch w.g. differential static pressure.
  2. Insulation: Interior surfaces acoustically and thermally lined with minimum 1 inch thick, fiberglass duct lining. Density 1-1/2 lb. per cu. ft. UL listed and labeled meeting UL 181 and ASTM C 1071. Exposed edges coated with NFPA 90A approved sealant.
  3. Primary Air Damper: Low-leakage with provisions for connecting actuator, maximum leak rate 9 cfm at 1 inch w.g. differential static pressure. Solid shaft rotating in Delrin or bronze oilite self-lubricating bearings. Shaft clearly marked on end to indicate damper position. Mechanical stop to prevent overstroking. Synthetic seals. Inlet sized to fit standard round duct.
  4. Primary Airflow Sensor: Integral flow-cross style multiple point, center averaging flow sensor for primary air flow measurement. Include integral flow taps and calibration chart on each unit. Annular type sensor not acceptable.
  5. Access Panel: Removable insulated panel on bottom of unit for access to interior of unit.
  6. Discharge Duct Connection: Slip and drive rectangular connection.
  7. Control Enclosure: Galvanized steel, with single point power supply connection and terminal block, control terminal block.
  8. Digital Controller: Microprocessor-based controller furnished under Section 230900, factory installed by VAV unit manufacturer.
  9. Primary Air Damper Actuator: Furnished under Section 230900, factory installed by VAV unit manufacturer.

- D. Electric Heater:
1. Description: Factory mounted electric resistance heater including open coil and control panel, installed at discharge of unit.
  2. Codes and Standards: Comply with UL 1996 and NEC. UL listed and labeled for zero clearance to combustible surfaces.
  3. Heater Casing: Galvanized steel construction, flanged connection.
  4. Coil: Derated 80 percent nickel and 20 percent chromium open resistance coils, Type A resistance wire, insulated by ceramic bushings.
  5. Control Panel: Galvanized steel, NEMA 1, with hinged door, knockouts, terminal blocks, wiring gutters, detailed wiring diagram, and factory-wired controls and interlock terminals.
  6. Controls and Interlocks:
    - a. Differential pressure airflow switch.
    - b. Disc-type automatic reset thermal cutout for primary protection and load carrying disc-type manual reset thermal cutout wired to each heater circuit for secondary protection.
    - c. De-energizing mercury type contactors.
    - d. Overcurrent protection for each circuit including dual element type fuses installed in phenolic blocks with reinforcing springs.
    - e. Fused disconnect switch with door interlock to disconnect ungrounded conductors.
    - f. Silicon Controlled Rectifiers (SCRs): For modulation of heater load directly, varying output from 0 to 100 percent of rated KW.
    - g. Control Power Transformer: Line voltage to 24 V, with primary fusing.
    - h. Terminal Blocks: Line terminal block for power supply, and control terminal block.
- E. Warranty: Single source by VAV unit manufacturer, including controls.
- F. VAV Unit Component Responsibility: VAV unit manufacturer shall coordinate shipping. Refer to Article "VAV Unit Component Responsibility Schedule" in this section.
- G. Manufacturers: Titus, Nailor Industries, Inc., ENVIRO-TEC®, or approved.

#### 2.07 ELECTRIC DUCT HEATERS, PROPORTIONAL CONTROLLED

- A. Description: Flanged type electric duct heater including open coil and control box for horizontal or vertical airflow as indicated on the Drawings.
- B. Codes and Standards: Comply with UL 1996 and NEC. UL listed and labeled for zero clearance to combustible surfaces.
- C. Coil: 80 percent nickel and 20 percent chromium open resistance coils, Type A resistance wire, insulated by ceramic bushings recessed into supporting brackets.
- D. Heater Casing: Galvanized steel construction sized to fit within unit casing, constructed for lined ducts.
- E. Control Box: Galvanized steel, NEMA 1, with hinged and latching door, knockouts, terminal blocks, wiring gutters, detailed wiring diagram, and factory-wired controls and interlock terminals.

- F. Controls and Interlocks:
1. Upstream and downstream temperature sensors for proportional control.
  2. Disc type automatic reset thermal cutout for primary protection and load carrying disc type manual reset thermal cutout wired to each heater circuit for secondary protection.
  3. De-energizing mercury type contactors.
  4. Overcurrent protection for each circuit including dual element type fuses installed in phenolic blocks with reinforcing springs.
  5. Fused disconnect switch with door interlock to disconnect ungrounded conductors.
  6. Control transformer with primary fusing.
  7. Proportional Control Package:
    - a. Silicon Controlled Rectifiers (SCRs): For modulation of heater load directly, varying output from 0 to 100 percent of rated KW.
    - b. Thermostatic Control: Coordinate control per Section 230900.
- G. Manufacturers: INDEECO, Valley Industries, Markel Products Company, Chromalox, Brasch Manufacturing Company, Neptronic, Nailor Industries, Inc., or approved.

## 2.08 CLOTHES DRYER VENT COMPONENTS

- A. Dryer Vent Receptacle: 22 gage aluminized steel receptacle with top or bottom opening for connection between flexible and rigid ducts. Include furring strip for installation in 2 by 4 wall. Powder coated finish. UL listed and labeled for installation in 1 hour fire rated wall. In-O-Vate Technologies Inc. Dryerbox® Recessed Dryer Receptacle Model DB-480 (561-743-8696) or approved.
- B. Dryer Lint Box: 24 gage galvanized steel construction with polycarbonate gasketed door with piano hinge and cam lock. Lint collector with interior angle support and handle. Four inch round connections on top and bottom. Columbia HVAC Products (1-877-620-82581) or approved.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. Description: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance", provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Do not cover up or enclose work until inspected and approved. If in non-compliance, uncover work, remove, and provide new to satisfaction of the A/E at no additional cost to the Owner.

**3.04 VOLUME DAMPERS**

- A. General: All required volume dampers are not shown on the Drawings. Install damper in duct to each supply, return, and exhaust opening and for branch mains serving more than 1 opening.
- B. Construction and Installation: In general, arrange with axis of blade in long dimension of rectangular duct. Install bearing on each end. Seal installation airtight.
- C. Location: Install dampers in accessible locations. Locate as far from outlet and inlet as possible.
- D. Remote Cable Control System: Install where ducts are not accessible. Install cables for multiple dampers and routed to common location as directed by the A/E.
- E. Setting: Set and lock in full open position, prior to TAB work.
- F. Install 12 inch long orange colored 1/2 inch wide surveyors tape on quadrant of volume dampers located above ceilings.

**3.05 AUTOMATIC BALANCING DAMPERS**

- A. General: Install in supply and exhaust ductwork locations as shown on the Drawings. Install per manufacturer's installation instructions.
- B. Location: Install dampers in accessible locations. Locate as far from outlet and inlet as possible.
- C. Install 12 inch long orange colored 1/2 inch wide surveyors tape on quadrant of volume dampers located above ceilings.

**3.06 SMOKE DAMPERS**

- A. General: Install per manufacturer's installation instructions. Install to prevent rattling and vibration. Utilize sleeves, angles and other materials so that installation is equivalent to that used by manufacturer when tested by UL.
- B. Actuators: Install smoke dampers so that actuators and other components mounted external to the damper are accessible. Install dampers so that actuators can be removed from damper shaft for replacement.
- C. Testing: Test smoke dampers per IBC, IFC, NFPA 80, and NFPA 105.

**3.07 ACCESS DOORS**

- A. General: Install at duct smoke detectors, motorized dampers, smoke dampers, both sides of duct mounted coils, and duct sensors, and plenums. Arrange door swings so that access doors open against air pressure.
- B. Access Doors for Smoke Dampers:
  - 1. Size large enough to permit resetting of damper and damper inspection. Minimum dimension 12 inch or maximum dimension allowed by duct size.
  - 2. Hinged and latched, or clamped with mechanism to allow easy removal.
  - 3. Tight fitting, full neoprene gasketed, constructed to prevent air leakage.
  - 4. Install permanent engraved phenolic nameplates in accordance with Section 230510, IBC, and IMC. Color as selected by the AHJ.
  - 5. Demonstrate to the Owner and A/E that damper can be reset and damper can be inspected.

**3.08 VARIABLE AIR VOLUME TERMINAL UNITS**

- A. General: Install to be accessible for service and maintenance to components by maintenance personnel standing on ladder, without need to reach over or around light fixtures, ceiling supports, piping, and similar obstructions.
- B. Coordination: Units located above inaccessible suspended ceilings will require access through access doors. Coordinate requirements for right or left hand access and connections to suit field connections. Access doors will be furnished and installed as part of general construction work but sizes shall be determined as part of the sheet metal work.
- C. Support units from structure similar to that for ducts and per details on the Drawings. Support devices shall not block access.
- D. Provide ceiling "dots" under the service and maintenance locations of each unit to allow maintenance personnel to identify locations of ceiling panels that need to be removed and reinstalled to access components. Obtain A/E approval of products to be used for this purpose and their method of attachment to ceiling.

**3.09 ELECTRIC DUCT HEATERS**

- A. Install to allow clearance in front of control box per NEC requirements.

**3.10 FILTERS**

- A. Filters during Construction: Install filters specified in Section 234100 over return air grilles and other return air openings for air handling systems that are operated during construction. Size filters to exceed the grille and opening sizes. Install to be airtight. Remove at end of construction prior to building flush-out mode.

**3.11 CLOTHES DRYER VENT LINT BOX AND RECEPTACLE**

- A. Install to be accessible above dryer.

**3.12 HVAC SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.



3.13 **COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

3.14 **VAV UNIT COMPONENT RESPONSIBILITY SCHEDULE**

ITEM	FURNISHED BY	MOUNTED BY	CONNECTED BY
1. VAV Unit	Unit Manufacturer	Mechanical Contractor	Mechanical Contractor (1)
2. Primary Air Damper Actuator	Control Subcontractor	Unit Manufacturer	Unit Manufacturer
3. Primary Airflow Sensor	Unit Manufacturer	Unit Manufacturer	Unit Manufacturer
4. Electric Heater	Unit Manufacturer	Unit Manufacturer	Electrical Contractor
5. Low Voltage Field Wiring (4)			Control Subcontractor
6. Air Flow Transducer	Control Subcontractor	Control Subcontractor (2)	
7. Temperature Sensor	Control Subcontractor	Control Subcontractor	Control Subcontractor
8. Digital Controller	Control Subcontractor	Unit Manufacturer (2)	
Notes:			
1. Duct and piping connections.			
2. Internal tubing and wiring by unit manufacturer, external (field) wiring by control subcontractor.			
3. If not integral to control valve.			
4. 24 V control power connected by control subcontractor.			

\*\*\*END OF SECTION\*\*\*

**SECTION 23 24 00  
AIR DISTRIBUTION EQUIPMENT**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes dedicated outdoor units, heat recovery units, fans, fan drives, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. AHRI 410, Forced-Circulation Air-Cooling and Air-Heating Coils.
  - 2. AHRI 1060, Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.
  - 3. AMCA Publication 99, Standards Handbook.
  - 4. AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
  - 5. AMCA Standard 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - 6. AMCA Publication 211, Certified Ratings Program – Product Rating Manual for Fan Air Performance.
  - 7. AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating.
  - 8. AMCA Publication 511, Certified Ratings Program – Product Rating Manual for Air Control Devices.
  - 9. ASHRAE 84, Method of Testing Air-to-Air Heat Exchangers.
  - 10. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - 11. UL 507, Standard for Electrical Fans.
  - 12. UL 705, Power Ventilators.
  - 13. UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.
  - 14. UL 1995, Heating and Cooling Equipment.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data, ladder-type wiring diagrams differentiating between portions of wiring that are factory installed and portions to be field-installed, and maintenance data for each air handling unit as follows: Include dimensions, weights, capacities, certifications, component performance, electrical characteristics, casing construction details, wiring interconnections, gages, and finishes of materials.
  - 1. Dedicated outdoor air units.

2. Heat recovery units.
  3. In-line centrifugal fans.
  4. Roof exhaust fans.
  5. Upblast roof exhaust fans.
  6. Blank copy of start-up and test report form.
- C. Performance Data: Submit fan performance curve for each dedicated outdoor air unit, heat recovery unit and fan. Indicate on separate graph for each fan and for combined fans operating in parallel, static pressure versus volume flow, efficiency, and brake horsepower, with scheduled design point shown and labeled. Indicate that fan performance curve will not exceed 90 percent of maximum efficiency. Performance certified in accordance with AMCA 210. A single fan curve not acceptable. Include coil selection worksheets, showing consideration for altitude, air density, fluid characteristics, and fouling factor.
- D. Test Reports:
1. Field start-up test reports.
  2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 - PRODUCTS

### 2.01 DEDICATED OUTDOOR AIR UNITS (DOAS)

- A. Description: Outdoor DOAS units shall include insulated steel cabinet, fixed plate heat exchanger with enthalpic cores, electric heat coil, fan and motor assembly, filter racks, and integral controls. Unit shall be factory tested and assembled and UL listed and labeled per UL 1995 or ETL.
- B. Cabinet:
1. General: Sections, dimensions, and service access spaces as indicated on the Drawings.
  2. Cabinet shall be nominal 2-inch double wall panel with R13 thermal insulation. Cabinet exterior shall be 18-gauge galvanized steel on base panels and 24-gauge pre-painted steel on wall and roof panels and meets or exceeds 650-hour salt spray test based on ASTM B117. Liners and other steel components shall be galvanized steel. All seams shall be sealed to provide airtight casing.
  3. Doors shall be nominal 2-inch double wall panel with the same construction as cabinet. Doors shall be fitted with hinges and door handles. The doors shall have one lockable handle as standard.
  4. Unit shall be configured for single side access service and maintenance from the front to allow for a compact installation.
  5. Dampers shall have extruded heavy gauge 6063 aluminum frame that includes jamb seals. Dampers shall be leakage Class 1A at 1 in. w.g. static pressure differential, following standard air leakage data certified under the AMCA Certified Ratings Program. Blades shall be airfoil shaped extruded aluminum and include rubber blade seals. Linkage shall be installed in the frame outside of the airstream.
  6. Dampers shall include factory mounted, wired and tested actuators. Dampers shall be modulating, or two-position as required. Provide spring return dampers for outdoor air connections.

7. Standing seam roof to provide weather protection for outdoor installation with exhaust air and outdoor air weather hoods with shutoff damper actuator access panels.

C. Fan:

1. Fans shall be mixed flow plenum type with direct drive motor. Fan and motor assembly shall be factory mounted and balanced. Allowable vibration, peak-to-peak displacement, not to exceed 2.0 mils. Select fans for point of design at maximum possible mechanical efficiency. At this point of design, the fan characteristic curve shall continuously slope for at least 10 percent of fan static pressure, both above and below point of design.
2. Fan motors shall be permanent magnet, synchronous motor type with integral digital motor controller. Fan bearings shall be serviceable type with an L-10 life of 40,000 hours. Fan motors will be UL approved. Comply with requirements in Section 230513.
3. Fans shall be equipped with integral airflow monitoring system connected to the unit controller.
4. Provide means to easily remove fan-motor assembly for service through standard man doors.
5. Fans should be designed such that all service can be performed in the field, including replacement of bearings.
6. Fan motor drives shall be 460/60/3 and be UL approved.
7. Vibration Isolation Mountings and Seismic Restraints: Internal isolation. Fan, motor, and drive isolated from casing and factory-mounted on welded steel isolation base. Comply with requirements in Section 230548 for vibration isolators and Section 230550 for seismic restraints.

D. Heat Exchanger:

1. Units shall include plate type counter flow heat exchanger fabricated with a polymer membrane and aluminum casing. Within the heat exchanger channels, maximum pressure differential shall be 7 inches w.g. and maximum leakage between airstreams shall be 0.5% of nominal airflow.
2. Units shall include bypass dampers with modulating actuators. Unit controller shall operate bypass dampers to maximize heat transfer without frosting and bypass heat exchanger during economizer mode.
3. The heat exchanger shall be installed over a stainless-steel double sloped condensate pan.

E. Electric Heating Coil:

1. Provide open coil electric heaters of the size, capacity and performance shown in the equipment schedules.
2. All duct heaters shall be tested and certified to UL and CSA.
3. Frame to be corrosion-resistant and made of galvanized steel.
4. Coils shall be made of high-grade Nickel-Chrome alloy and shall be insulated from the frame by means of non-rotating ceramic bushings.
5. Heater to come with door mounted disconnect switch and air proving switch.
6. SCR control is time proportioning type that modulates the heater and supplies the exact amount of power to match the demand. Input signal will be 0-10V.
7. Heaters shall be equipped with a fail-safe automatic reset disc-type thermal cut-out located in the top frame component above the heating element.

8. Duct heaters shall be non-sensitive to air flow direction for horizontal or vertical ducts without impairing safety.
- F. Filters: Side access filter housing with MERV ratings as indicated in equipment schedules. Comply with requirements in Section 234100.
- G. Roof Curb: Fabricate from 12 gage galvanized steel with interior of curb insulated with 2 inch thick 1-1/2 pound per cubic foot density neoprene coated fiberglass insulation. Include continuous 2 inch by 4 inch wood nailing strip and 2 inch by 3/4 inch thick closed cell neoprene sealing gasket. Minimum 10 inch above roof surface. Comply with requirements in Sections 230548 and 230550. Refer to architectural drawings for roof and roof insulation requirements.
- H. Controls:
  1. Unit shall include an integrated microprocessor-based unit controller. The controls shall be located in the integral controls cabinet. All unit controls shall operate off a transformer from the main power supply for single point power connection. All internal controls and sensors shall be factory prewired and tested.
  2. The control system will regulate temperatures, airflows and other functions as required. Unit controller shall be pre-programmed with factory tested software for all possible functions.
  3. The controller shall provide the following, refer to sequence of operation for specific unit control sequences;
    - a. Control of fans correcting for both changes in total static pressure and air density in both VAV and constant airflow applications.
    - b. Fan performance monitoring.
    - c. Ventilation airflow monitoring and control.
    - d. Airflow density correction for winter and summer conditions.
    - e. Energy recovery optimization including operation of bypass damper.
    - f. Supplemental heating.
    - g. Frost protection.
    - h. Monitoring alarms, faults and maintenance points including filter changeout.
    - i. Time and date schedules.
    - j. Data logging and trending.
  4. Controller shall be BACnet IP and BTL certified and include Modbus communication. Communication shall include monitoring, control, alarms, faults and maintenance information.
  5. Provide factory installed and tested contactors, overloads, fusing, starters motor speed controllers for supply and exhaust. Include all necessary control transformers.
  6. Provide unit mounted non-fused disconnect switch with single point power connection.
  7. Supply all necessary temperature and pressure sensors complete with plug in wiring harnesses for proper option of unit.
- I. Electrical:
  1. Description: Factory wired for single point electrical connection. Electrical connection to fan motor made with flexible conduit sufficiently long for vibration isolation.

2. Components and Wiring: Comply with NEC and Division 26 requirements. UL or ETL listed and labeled. Number coded per wiring diagrams. Label electrical components per wiring diagrams.

J. Manufacturers: Oxygen 8 Ventum+, Systemair, Multistack Auragreen, or approved.

## 2.02 HEAT RECOVERY UNITS (HRU)

A. Description: Outdoor heat recovery units shall include insulated steel cabinet, fixed plate heat exchanger with enthalpic cores, split DX coil with factory mounted expansion valve kit and factory mounted and wired HRU integration controller, fan and motor assembly, filter racks, and integral controls. Unit shall be factory tested and assembled and UL listed and labeled per UL 1995 or ETL.

B. Cabinet:

1. General: Sections, dimensions, and service access spaces as indicated on the Drawings.
2. Cabinet shall be nominal 2-inch double wall panel with R13 thermal insulation. Cabinet exterior shall be 18-gauge galvanized steel on base panels and 24-gauge pre-painted steel on wall and roof panels and meets or exceeds 650-hour salt spray test based on ASTM B117. Liners and other steel components shall be galvanized steel. All seams shall be sealed to provide airtight casing.
3. Doors shall be nominal 2-inch double wall panel with the same construction as cabinet. Doors shall be fitted with hinges and door handles. The doors shall have one lockable handle as standard.
4. Unit shall be configured for single side access service and maintenance from the front to allow for a compact installation.
5. Dampers shall have extruded heavy gauge 6063 aluminum frame that includes jamb seals. Dampers shall be leakage Class 1A at 1 in. w.g. static pressure differential, following standard air leakage data certified under the AMCA Certified Ratings Program. Blades shall be airfoil shaped extruded aluminum and include rubber blade seals. Linkage shall be installed in the frame outside of the airstream.
6. Dampers shall include factory mounted, wired and tested actuators. Dampers shall be modulating, or two-position as required. Provide spring return dampers for outdoor air connections.
7. Standing seam roof to provide weather protection for outdoor installation with exhaust air and outdoor air weather hoods with shutoff damper actuator access panels.

C. Fan:

1. Fans shall be mixed flow plenum type with direct drive motor. Fan and motor assembly shall be factory mounted and balanced. Allowable vibration, peak-to-peak displacement, not to exceed 2.0 mils. Select fans for point of design at maximum possible mechanical efficiency. At this point of design, the fan characteristic curve shall continuously slope for at least 10 percent of fan static pressure, both above and below point of design.
2. Fan motors shall be permanent magnet, synchronous motor type with integral digital motor controller. Fan bearings shall be serviceable type with an L-10 life of 40,000 hours. Fan motors will be UL approved. Comply with requirements in Section 230513.
3. Fans shall be equipped with integral airflow monitoring system connected to the unit controller.

4. Provide means to easily remove fan-motor assembly for service through standard man doors.
  5. Fans should be designed such that all service can be performed in the field, including replacement of bearings.
  6. Fan motor drives shall be 460/60/3 and be UL approved.
  7. Vibration Isolation Mountings and Seismic Restraints: Internal isolation. Fan, motor, and drive isolated from casing and factory-mounted on welded steel isolation base. Comply with requirements in Section 230548 for vibration isolators and Section 230550 for seismic restraints.
- D. Heat Exchanger:
1. Units shall include plate type counter flow heat exchanger fabricated with a polymer membrane and aluminum casing. Within the heat exchanger channels, maximum pressure differential shall be 7 inches w.g. and maximum leakage between airstreams shall be 0.5% of nominal airflow.
  2. Units shall include bypass dampers with modulating actuators. Unit controller shall operate bypass dampers to maximize heat transfer without frosting and bypass heat exchanger during economizer mode.
  3. The heat exchanger shall be installed over a stainless-steel double sloped condensate pan.
- E. DX Heat Pump Coil:
1. Unit shall include AHRI 410 tested fin tube type DX coil for use with R-410A. Fins shall be aluminum with a minimum thickness of 0.006 inches. Tubes shall be minimum 3/8 inch outside diameter with a minimum 0.014 inch tube wall seamless copper tube mechanically expanded into fins. Coil casings shall be galvanized steel. Coils shall include external drain and vent connections. Coil shall be mounted in a rack over a stainless-steel double sloped condensate pan.
  2. Provide with HRU integration controller (EKEQ) factory mounted and wired to EKEXV expansion valve kit.
  3. Liquid and Gas thermistors are to be mounted to coil and wired to EKEQ kit in the factory.
  4. EKEXV expansion valve kit will be mounted, and connections will be brazed to coil. Liquid and Gas lines to be capped at outside of AHU. Coil and EKEXV kit must be tested to 650 psi, and then nitrogen charged for shipment to site.
- F. Filters: Side access filter housing with MERV ratings as indicated in equipment schedules. Comply with requirements in Section 234100.
- G. Roof Curb: Fabricate from 12 gage galvanized steel with interior of curb insulated with 2 inch thick 1-1/2 pound per cubic foot density neoprene coated fiberglass insulation. Include continuous 2 inch by 4 inch wood nailing strip and 2 inch by 3/4 inch thick closed cell neoprene sealing gasket. Minimum 10 inch above roof surface. Comply with requirements in Sections 230548 and 230550. Refer to architectural drawings for roof and roof insulation requirements.
- H. Controls:
1. Unit shall include an integrated microprocessor-based unit controller. The controls shall be located in the integral controls cabinet. All unit controls shall operate off a transformer from the main power supply for single point power connection. All internal controls and sensors shall be factory prewired and tested.

2. The control system will regulate temperatures, airflows and other functions as required. Unit controller shall be pre-programmed with factory tested software for all possible functions.
  3. The controller shall provide the following, refer to sequence of operation for specific unit control sequences;
    - a. Control of fans correcting for both changes in total static pressure and air density in both VAV and constant airflow applications.
    - b. Fan performance monitoring.
    - c. Ventilation airflow monitoring and control.
    - d. Airflow density correction for winter and summer conditions.
    - e. Energy recovery optimization including operation of bypass damper.
    - f. Heating and cooling.
    - g. Frost protection.
    - h. Monitoring alarms, faults and maintenance points including filter changeout.
    - i. Time and date schedules.
    - j. Data logging and trending.
  4. Controller shall be BACnet IP and BTL certified and include Modbus communication. Communication shall include monitoring, control, alarms, faults and maintenance information.
  5. Provide factory installed and tested contactors, overloads, fusing, starters motor speed controllers for supply and exhaust. Include all necessary control transformers.
  6. Provide unit mounted non-fused disconnect switch with single point power connection.
  7. Supply all necessary temperature and pressure sensors complete with plug in wiring harnesses for proper option of unit.
- I. Electrical:
1. Description: Factory wired for single point electrical connection. Electrical connection to fan motor made with flexible conduit sufficiently long for vibration isolation.
  2. Components and Wiring: Comply with NEC and Division 26 requirements. UL or ETL listed and labeled. Number coded per wiring diagrams. Label electrical components per wiring diagrams.
- J. Manufacturers: Oxygen 8 Ventum+, Systemair, Multistack Auragreen, or approved.

## 2.03 IN-LINE CENTRIFUGAL FANS

- A. Description: Direct drive in-line centrifugal fan as indicated on the Drawings. Arrangement, accessories, and motor as indicated in the Contract Documents. UL listed and labeled.
- B. Construction:
1. Housing: Galvanized steel, internally lined with 1 inch thick fiberglass neoprene coated duct liner with exposed edges sealed with adhesive. Include access panel, self-contained removable drive door, adjustable motor base, belt tunnel, support brackets, automatic belt tensioner, and inlet and outlet duct connections. Baked enamel finish.
  2. Wheel: Aluminum, backward inclined, statically and dynamically balanced.
  3. Bearings: Self-aligning, relubricable ball type with cast iron flanges and locking collars, L-50 life at 200,000 hours.



- C. Motor: Comply with requirements in Section 230513.
- D. Electrical:
  - 1. Factory wired from junction box mounted on exterior of unit to motor. Electrical connection to fan motor made with flexible conduit sufficiently long for vibration isolation.
  - 2. Variable Speed Controller: Factory or field installed and connected on junction box cover.
- E. Manufacturers: Greenheck Fan Corporation SQ Series, Loren Cook Company, or approved.

#### 2.04 ROOF EXHAUST FANS

- A. Description: Factory assembled, roof mounted, direct drive as indicated on the Drawings with backward inclined centrifugal fan. UL 705 listed and labeled. See the Drawings for additional requirements.
- B. Construction: Weatherproof, spun aluminum housing with internal supports, aluminum curb cap. Aluminum, non-overloading fan wheel. Wheel dynamically balanced per AMCA 204. Motor and drive assembly mounted on rubber vibration isolators.
- C. Motor: Comply with requirements in Section 230513.
- D. Bearings: Regreasable ball type in cast iron pillow block housing, L-50 life at 200,000 hours.
- E. Accessories: Aluminum birdscreen with 85 percent free area, solid state variable speed controller mounted on junction box within housing for direct drive fans, and prefabricated metal insulated roof curb with cant strip. Minimum 10 inch above roof surface. Comply with requirements in Sections 230548 and 230550. Refer to architectural drawings for roof and roof insulation requirements.
- F. Manufacturers: Greenheck Fan Corporation, Loren Cook Company, or approved.

#### 2.05 UPBLAST ROOF EXHAUST FANS

- A. Description: Factory assembled, roof mounted, upblast, direct drive as indicated on the Drawings with backward inclined centrifugal fan. UL 705 listed and labeled. Tested, rated, certified, and labeled in accordance with AMCA 211 and 311.
- B. Construction: Weatherproof, spun aluminum housing with internal supports, aluminum curb cap. Fan wheel aluminum, non-overloading, dynamically balanced. Include automatic belt tensioner. Fan forced cooled with outside air.
- C. Motor: Comply with requirements in Section 230513.
- D. Bearings: Ball type, L-50 life at 200,000 hours.
- E. Accessories: Aluminum birdscreen with 85 percent free area, solid state variable speed controller mounted on junction box within housing for direct drive fans, and prefabricated metal insulated roof curb with cant strip. Minimum 10 inch above roof surface. Comply with requirements in Sections 230548 and 230550. Refer to architectural drawings for roof and roof insulation requirements.

- F. Manufacturers: Greenheck Fan Corporation, Loren Cook Company, or approved.

**PART 3 - EXECUTION**

**3.01 INSPECTION**

- A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION AND PERFORMANCE**

- A. Description: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Coordinate with ductwork and piping as necessary to interface installation of air handling equipment and access to components.
- C. Coordination: Coordinate required electrical and control installation work with Division 26 and Section 230900.

**3.04 WORK PRIOR TO INSTALLATION**

- A. Equipment manufacturer's authorized representative shall maintain personnel within a 50 mile radius of job site. Representative capable of troubleshooting air handling unit faults.
1. Include 1 man day to meet with mechanical, electrical and control subcontractors and mechanical engineer at job site. Schedule this meeting within 1 week after equipment is delivered to final location at job site but prior to equipment operation. Purpose is to assure that all parties understand what interconnections are required.
  2. After equipment installation, include 1 man day to assist control and electrical subcontractors in termination of interconnecting wires in unit mounted control panels. This service shall also verify proper connection and polarity of wires.

**3.05 INSTALLATION OF AIR HANDLING EQUIPMENT AND COMPONENTS**

- A. Install equipment with clearances for service and maintenance.
- B. Repair damaged coil fins.
- C. Exterior Mounted DOAS and Heat Recovery Units: Attach roof curbs to roof and attach units to roof curbs. Comply with requirements in Section 230548 for vibration isolators and Section 230550 for seismic restraints. Refer to architectural drawings for roof flashing.

- D. Suspended Fans: Provide hanger rods to support fan unit from roof structure. Comply with requirements in Section 230510 for formed steel channels and supplementary steel framing, Section 230548 for vibration isolators, and Section 230550 for seismic restraints.
- E. Roof Exhaust and Upblast Roof Exhaust Fans: Attach manufacturer's roof curbs to roof and mount fans on roof curbs. Refer to architectural drawings for roof flashing.
- F. Exterior Installations: Hot dip galvanized hardware and steel support frames for roof mounted fans.

**3.06 CLEANING**

- A. Air handling equipment shall remain sealed except during installation. When daily activities have been completed, clean and seal unit. Do not use compartments for storage.
- B. Thoroughly clean plenums and casings of debris and blow free small particles of rubbish and dust before making final duct connections. Prior to startup, clean to remove traces of oil, dust, and dirt. Vacuum clean fan wheels, exterior surfaces of casings, and entering air face of coils.

**3.07 ADJUSTING**

- A. Adjust fans deliver design airflow. Comply with requirements in Section 230593.
- B. Lubricate bearings with oil or grease as recommended by manufacturer.
- C. Adjust damper linkages for proper damper operation.

**3.08 HVAC SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

**3.09 COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 37 00  
AIR DEVICES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes grilles, diffusers, roof hoods and caps, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASHRAE 70, Method of Testing for Rating the Performance of Air Outlets and Inlets.
  - 2. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of the following:
  - 1. Grilles, registers, and diffusers.
  - 2. Roof hoods and caps.

**PART 2 - PRODUCTS**

**2.01 GRILLES, REGISTERS, AND DIFFUSERS**

- A. Except as otherwise indicated, furnish manufacturer's standard grilles and diffusers of size, shape, capacity and type as indicated on the Drawings for complete installation.
- B. Performance: Furnish grilles and diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each grille and diffuser type and size as listed in manufacturer's current data.
- C. Ceiling Compatibility: Furnish with border styles compatible with adjacent ceiling systems specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to architectural drawings and specifications for types of ceiling systems.
- D. Seismic Restraints for Grilles and Diffusers Weighing Less than 20 Pounds: Include means to positively attach grilles and diffusers to ceiling grid system.

- E. Manufacturers General: Titus, Krueger-HVAC, Anemostat, Metalaire™, Kees, Inc., Tuttle & Bailey®, Nailor Industries Inc., Price Industries, Greenheck or approved.

## 2.02 ROOF HOODS AND CAPS

- A. Range Hood and Clothes Dryer Vent Cap:
  - 1. Description: Weathertight aluminum construction, integral birdscreen (range hood only) and backdraft damper, curb cap.
  - 2. Roof Curb: 12 inch high insulated curb for flat or pitched roofs as applicable.
  - 3. Manufacturers: Greenheck Fan Corp. Model RCC-7, PennBarry™, or approved.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of grilles and diffusers with other work.
- C. Install grilles and diffusers level and plumb.
- D. Install grilles and diffusers with airtight connection to ducts and to allow service and maintenance of adjustable components.
- E. Ceiling-Mounted Air Devices: Drawings indicate general arrangement of ducts, fittings, and accessories. Grille and diffuser locations have been indicated on the Drawings to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated on the architectural reflected ceiling plans. For grilles and diffusers installed in lay-in ceiling panels, locate in center of panel. Where architectural features or other items conflict with installation, notify A/E for determination of final location.
- F. Seismic Restraints:
  - 1. For Grilles and Diffusers Weighing Less than 20 Pounds: Positively attach grille and diffuser to ceiling grid system.

2. For Grilles and Diffusers Weighing 20 to 56 Pounds: In addition to positively attaching grille and diffuser to ceiling grid system, install two No. 12 gage hanger wires connected to grille and diffuser to ceiling system hanger or to structure above.
  3. For Grilles and Diffusers Weighing More than 56 Pounds: Support directly from structure above. Comply with requirements in Section 230550 for seismic restraints.
- G. Secure roof curbs for roof hoods and caps and secure roof hoods and caps to top of curbs.
- H. Connect ducts to louvers as indicated on the Drawings. Apply sealant to make installation watertight.
- I. Anchor sleeves for brick vents to wall opening.

3.04 **ADJUSTING**

- A. After installation, adjust grilles and diffusers to air patterns indicated on the Drawings, or as directed by the A/E before starting air balancing.

3.05 **CLEANING**

- A. After installation of grilles and diffusers, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Remove and provide new grilles and diffusers that have damaged finishes.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 41 00  
FILTERS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes air filters for air handling equipment and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASHRAE 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
  - 2. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - 3. UL 900, Standard for Air Filter Units.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230510.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Filters.
  - 2. Filter housings and frames.
  - 3. Resistance indicator.
  - 4. Filters during construction.
  - 5. Blank copy of start-up and test report forms.
- C. Test Reports:
  - 1. Start-up and test reports.
  - 2. Submit completed copy of reports and include in the Operations and Maintenance Manual.
- D. Certification: Submit certificate signed by the Owner as to receipt of spare filters.

**1.04 SPARE MEDIA**

- A. For Dedicated Outdoor Air Units, Heat Recovery Units, and Packaged HVAC Equipment, and Similar Equipment with Filters: Four sets of each type of filter. One for initial installation, one installed prior to TAB work specified in Section 230593, one installed after final flush out, and one delivered to the Owner at Substantial Completion. Label filter boxes with equipment numbers as included in the equipment schedules on the Drawings.

**PART 2 - PRODUCTS**

**2.01 FILTERS**

- A. Pleated Media Type: Extended surface with reinforced non-woven cotton fabric in self-supporting frame, MERV 8 or MERV 13 per ASHRAE 52.2, 2 as evaluated under Appendix J, 2 inch thick, UL 900.
- B. Manufacturers: Camfil 30/30, AAF International, Flanders® Corporation, or approved.

**2.02 FILTER HOUSINGS AND FRAMES**

- A. For Air Handling Equipment: Filter housings and frames furnished by air handling equipment manufacturer and integral to air handling equipment unless otherwise indicated on the Drawings. Air handling equipment filter frames sized for filter media as specified in this section and as indicated on the Drawings. Filter access through hinged side servicing access doors with sash locks or rear access where space is available.
- B. Side Servicing Access:
1. General: Factory fabricated and assembled, 16 gage galvanized steel housing and frames, reinforced corners, access doors on each side, with sponge neoprene peripheral gasket, maximum leakage 1 percent at 3 inch w.g.
  2. Dimensions: Size for filter media with filter as specified in this Section and as indicated on the Drawings.

**2.03 RESISTANCE INDICATOR**

- A. General: Diaphragm-actuated dial type, 4-3/4 inch outside diameter with white dial, black figures and graduations, and pointer zero adjustment, 0 to 1 inch w.g. range with 0.02 inch minor division. Accuracy plus or minus 2 percent of full scale at 70 F. Include bracket, static pressure taps, aluminum tubing, and vent valves. Manufacturer: Dwyer® Magnehelic® Model 2001 or approved.

**2.04 FILTERS DURING CONSTRUCTION**

- A. General: Pleated media type with reinforced synthetic blend filter media that has been electrostatically charged, MERV 8 per ASHRAE 52.2, 1 inch thick, UL 900.
- B. Manufacturers: Camfil Aeropleat IV+, Flanders® Corporation, or approved.



PART 3 - EXECUTION

3.01 **INSPECTION**

- A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 **PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

3.03 **INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Coordinate with ductwork and air moving equipment as necessary to interface installation of and access to filters.
- C. Install filters in proper position to prevent passage of unfiltered air.

3.04 **HVAC SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

3.05 **COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 81 00  
PACKAGED HVAC EQUIPMENT**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes packaged HVAC equipment with mechanical heating and cooling capabilities and associated appurtenances and refrigerant piping for ductless split heat pump and variable refrigerant flow (VRF) systems.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Applicable energy code.
  - 2. AMCA 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
  - 3. AHRI 210/240, Performance Rating of Unitary Air-Conditioning and Air Source Heat Pump Equipment.
  - 4. AHRI 270, Sound Rating of Outdoor Unitary Equipment.
  - 5. AHRI 340/360, Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
  - 6. ASCE 7, Minimum Design Loads For Buildings and other Structures.
  - 7. ASTM B 117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
  - 8. MSS SP- 58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
  - 9. MSS SP- 69, Pipe Hangers Supports – Selection and Application.
  - 10. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - 11. UL 1995, Heating and Cooling Equipment.
- C. Refrigeration Piping Subcontractor Specified in Section 232300: Responsible for matching refrigeration equipment specified in this section, air handling equipment and their direct expansion cooling coils specified in Section 233400, and refrigeration piping and specialties specified in Section 232300.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following: Indicate accessories where required for complete system and installation instructions.
  - 1. Rooftop heat pumps

2. Ductless split heat pump system.
  3. Variable refrigerant flow (VRF) split heat pump system.
  4. Variable refrigerant flow (VRF) heat pump.
  5. Refrigerant piping for ductless split heat pump system and VRF systems.
  6. Blank copy of start-up and test report forms.
- C. Performance Data: Submit fan performance curve for unit. Indicate on separate graph for each fan, static pressure versus volume flow, efficiency, and brake horsepower, with scheduled design point shown and labeled. Performance certified in accordance with AMCA 210. A single fan curve not acceptable.
- D. Shop Drawings: Submit packaged HVAC equipment control wiring diagram indicating factory and field installed wiring.
- E. Test Reports:
1. Factory start-up and test reports.
  2. Field start-up and test reports.
  3. Submit completed copy of report and include copy in the Operations and Maintenance Manual.

#### 1.04 WARRANTY

- A. General: Warrant variable refrigerant flow (VRV) system components for 10 years after Substantial Completion date. Warranty shall cover material, labor, and travel time. Make available replacement within 48 hours of initial notification.

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

- A. Section 230900 – Automatic Temperature Controls: Zone temperature sensors, thermostats, and similar control devices for packaged HVAC equipment.

### PART 2 - PRODUCTS

#### 2.01 ROOFTOP HEAT PUMPS

- A. Description: Air-to-air electric heat pump designed to function as a year-round heating and air conditioning system. Factory assembled and tested with refrigerant charge and designed for downflow duct connections. Rated in accordance with AHRI 210/240 for air-to-air heat pumps. Heat pump heating capacity indicated includes effect of defrost cycles (integrated rating). UL listed and labeled.
- B. Cabinet, Casing, and Frame:
1. Double-wall construction for all panels. Floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a two-part injected foam with 1-inch minimum thickness and an R-value of 7. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5 inches w.g.

2. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure.
3. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule to provide user access to unit components. All service access doors shall be mounted on multiple stainless-steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
4. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

C. Outdoor/Return Air Section:

1. Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The outside and return air dampers shall be sized to handle 100 percent of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges.
2. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.
3. Provide factory installed and tested, outdoor air monitor that controls outdoor air +/- 15 percent accuracy down to 40 cfm per ton.

D. Supply Fan:

1. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Fan assemblies shall be statically and dynamically balanced at the factory.
2. Fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

3. Supply fan shall be capable of airflow modulation from 30-100 percent of the scheduled designed airflow. Unit controller shall proportional control the EC motors on the supply fan based on space temperature. Controller shall increase/decrease the speed of the supply fan in order to maintain the space temperature within its setpoint and deadband. The unit controller shall provide discharge air temperature control with the compressor modulation.
- E. Exhaust Fan:
1. Provide with exhaust fan where indicated in Contract Drawing Equipment Schedules.
  2. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft.
  3. Fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
  4. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25-100 of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.
- F. Filters: Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2 inch thick MERV-8 pre-filter and a 4 inch thick MERV-13 final filter. Only the MERV-8 filters shall be installed initially. Comply with requirements in Section 234100.
- G. Cooling Coil:
1. Indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and a double sloped drain pan.
  2. Direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design. Coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. Coils shall be factory leak tested with high pressure air under water.
  3. Coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
  4. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8 inches per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil.

- H. Heat Pump Heating:
1. The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
  2. The refrigerant system shall have a pump-down cycle.
  3. The unit shall have a hot water coil for hybrid heating. When the heat pump operation cannot maintain the discharge air temperature setpoint the hot water heating coil shall satisfy the additional heating demand.
- I. Electric Heat
1. The rooftop unit shall include an electrical resistance heating coil section installed downstream of the supply air fan in the heating section of the rooftop unit. Heating coils shall be constructed of a low watt density, nickel - chromium alloy resistance wire with intermediate supports that include ceramic bushings. The electrical contactors shall be of the full line-breaking type with all the electrical power legs being disconnected when the contactors are not energized. All electrical circuit wiring shall be designed with copper conductors, aluminum wires are not acceptable. The power supply for the electric heater shall be factory wired into the units main power block or disconnect switch.
  2. The heating coil shall have an automatic reset, high temperature limit safety protection. A secondary high limit protection shall also be provided that requires a manual reset. An airflow switch shall be provided with the heating module to prevent the electric heater from operating in the event of no airflow.
  3. The electric heater elements shall be controlled by the factory installed DDC unit control system. The heater shall have SCR control.
- J. Roof Curb: Fabricate from 12 gage galvanized steel with interior of curb insulated with 2 inch thick 1-1/2 pound per cubic foot density neoprene coated fiberglass insulation. Include continuous 2 inch by 4 inch wood nailing strip and 2 inch by 3/4 inch thick closed cell neoprene sealing gasket. Minimum 10 inch above roof surface. Comply with requirements in Sections 230548 and 230550. Refer to architectural drawings for roof and roof insulation requirements.
- K. Electrical: The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 120- volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

L. Controls:

1. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. System shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
2. DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand-alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
3. DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/ disable, heat indication, cool indication, and fan operation.
4. Digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
5. DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. Unit shall also have the ability to accept a time schedule via BAS network communications.
6. The keypad interface shall allow convenient navigation and access to all control functions.
7. Controller shall be equipped with dry contacts for unit shutdown from the fire alarm system.
8. Unit shall be provided with a factory mounted BACnet IP integration card.

M. Manufacturers: Daikin Rebel, Trane, Valent, or approved.

**2.02 DUCTLESS SPLIT HEAT PUMP SYSTEM**

- A. Description: Matched packaged equipment operating on R-32. System consists of evaporator (indoor unit) and outdoor unit with direct expansion (DX) air-cooled heat pump system. Rated and certified in accordance with AHRI 210/240. UL 1995 listed and labeled.
- B. Outdoor Unit:
1. Description: Factory assembled, piped, and wired with electronic and refrigerant controls. Factory run tested. Designed to operate:
    - a. In Heating Mode: Down to minus 4 F outdoor air temperature and down to minimum 64 F outdoor wet bulb temperature without low ambient control.
    - b. In Cooling Mode: Down to 14 F and up to 118 F outdoor air temperature.
  2. Cabinet: Pre-coated metal with base legs tested per ASTM B 117 salt spray test procedure for minimum 1000 hours.
  3. Refrigerant Circuits: Include refrigerant strainer, accumulator, four way reversing valve, and electronic expansion valve, .

4. Compressors: Inverter digitally controlled hermetic twin rotary type with Teflon™ coated bearings overcurrent protection, and vibration isolation.
5. Unit Controls: Include control boards to operate system from outdoor unit and indoor units via 4 conductor, stranded and shielded cable. Microprocessor-based system for component protection, soft-start capability, refrigeration system pressure, temperature, defrost, and ambient control.
6. Fan and Motor: Propeller type with ABS plastic blades, statically and dynamically balanced, horizontal discharge, direct drive. Motors with inherent overload protection and permanently lubricated bearings, variable speed. Include metal fan guard.
7. Condenser Coil Aluminum fins on copper tubing. Fins with corrosion resistant material with hydrophilic coating tested per ASTM B 117 salt spray test procedure for minimum 1000 hours. Include metal guard.

C. Indoor Unit (Wall Mounted):

1. Description: Unit wall mounted type for installation within conditioned space connected to heat pump unit. Factory assembled and tested with wiring, piping, electronic expansion valve, control circuit board, fan and motor, condensate drain pan, self-diagnostic function and auto-restart functions. Include with wired temperature controller.
2. Cabinet: Affixed to factory supplied wall mounting back plate. Include manually adjustable airflow guide vane for units less than 15 Mbh and motorized sweeping airflow guide vane for units greater than 18 Mbh.
3. Fan and Motor: Direct drive, cross flow fan, statically and dynamically balanced, fan speed controlled using microprocessor-based DDC control for high speed for cooling "ON" and low fan speed for cooling "OFF" and high speed fan for heating "ON" and fan off for heating "OFF". Fan speeds adjustable between "LOW", "MEDIUM", "HIGH", and "SUPER HIGH". Motor with permanently lubricated and sealed bearings. Fan/motor assembly mounted on rubber grommets.
4. Filter: Removable, washable return air filter.
5. Coil: Direct expansion type constructed from copper tubes expanded into aluminum fins. Tubes with internal grooves, factory pressure tested and factory charged with dry nitrogen. Include condensate pan constructed of expanded polystyrene resin below coil with insulated flexible drain piping. Include with condensate pump.

D. Manufacturers: Daikin, Samsung, LG Electronics DFS Series, or approved.

2.03 **VARIABLE REFRIGERANT FLOW (VRF) SPLIT HEAT PUMP SYSTEM**

- A. Description: Variable capacity, heat recovery, heat pump system utilizing variable refrigerant flow and operating on R-410a. System consists of multiple evaporators (indoor units) using inverter driven outdoor unit. Outdoor unit with direct expansion (DX) air-cooled heat pump system with variable speed driven compressor. Heat recovery unit with tubing connections. Each indoor unit capable of operating separately with individual temperature control.

B. Outdoor Unit:

1. Description: Factory assembled, piped, and wired with electronic and refrigerant controls. Factory run tested. Designed to operate:
  - a. In Heating Mode: Down to minus 13 F outdoor air temperature and up to 61 F outdoor wet bulb temperature.
  - b. In Cooling Mode: Down to 14 F and up to 122 F outdoor air temperature.



2. Cabinet: Galvanized steel plate, bonderized with baked enamel finish.
  3. Refrigerant Circuits Include refrigerant strainer, check valves, oil separator, accumulator, four way reversing valve, electronic expansion valves, high pressure and low pressure refrigerant charging ports, high pressure safety switch, service valves, interconnecting piping, and oil injection mechanism. Include subcooling heat exchanger.
  4. Compressors: Inverter controlled hermetic scroll compressors. Each compressor with crankcase heater, internal thermal overloads, and vibration isolators.
  5. Unit Controls: Include control boards to operate VRF system and communicate in daisy chain configuration from outdoor unit to heat recovery unit to indoor units via 2 conductor, stranded and shielded cable for RS-485 communication.
  6. Fan and Motor: Propeller type, vertical discharge, direct drive, variable speed fan motors. Motors with inherent protection and permanently lubricated bearings, variable speed, and fan guard.
  7. Condenser Coil: Aluminum fins on copper tubing. Fins with corrosion resistant material with hydrophilic coating. Include integral metal guard.
- C. Branch Distribution Unit:
1. Description: Factory assembled, internally piped, and wired with electronic and refrigerant controls. Factory run tested. Designed for indoor installation.
  2. Cabinet: Galvanized steel, internally insulated.
  3. Refrigerant Circuit: Y-branch kits, multiple ports to serve indoor units, each port with subcooling heat exchanger and two 2 position solenoid valves. Include tubing provisions for field furnished and installed isolation valves.
  4. Unit Controls: Include control boards to operate VRF system and communicate in daisy chain configuration from outdoor unit and indoor units via 4 conductor, stranded and shielded cable for RS-485 communication.
  5. Include microprocessors to communicate with main controller in outdoor unit.
- D. Indoor Unit (4-Way Ceiling Cassette):
1. Description: Unit recessed mounted type with 4-way discharge pattern connected to heat pump unit. Factory assembled and tested with wiring, piping, electronic expansion valve, control circuit board, fan and motor, condensate drain pan, self-diagnostic function and auto-restart functions. Include integral sensor within cabinet for use with wireless remote controller.
  2. Cabinet: Include provisions for field installed outside air. Include filter grille on bottom of unit for 2-, 3-, or 4-way airflow.
  3. Fan and Motor: Direct drive, cross flow fan, statically and dynamically balanced, fan speed controlled using microprocessor-based DDC control for high speed for cooling "ON" and low fan speed for cooling "OFF" and high speed fan for heating "ON" and fan off for heating "OFF". Fan speeds adjustable between "LOW", "MEDIUM", and "HIGH". Motor with permanently lubricated and sealed bearings. Fan/motor assembly mounted on rubber grommets.
  4. Filter: Removable, washable return air filter with anti-fungal treatment.
  5. Coil: Direct expansion type constructed from copper tubes expanded into aluminum fins. Tubes with internal grooves, factory pressure tested and factory charged with dry nitrogen. Include condensate pan below coil constructed of expanded polystyrene resin below coil and condensate pump.

- E. Indoor Unit (Fan Coil):
1. Description: Unit concealed type with inlet and outlet connections and connected to heat pump unit. Factory assembled and tested with wiring, piping, electronic expansion valve, control circuit board, fan and motor, condensate drain pan, self-diagnostic function and auto-restart functions. Include integral sensor within cabinet for use with wireless remote controller.
  2. Cabinet: Include provisions for field installed outside air duct. Include inlet and outlet duct openings and filter opening.
  3. Fan and Motor: Direct drive, cross flow fan, statically and dynamically balanced, fan speed controlled using microprocessor-based DDC control for high speed for cooling "ON" and low fan speed for cooling "OFF" and high speed fan for heating "ON" and fan off for heating "OFF". Fan speeds adjustable between "LOW", "MEDIUM", and "HIGH". Motor with permanently lubricated and sealed bearings. Fan/motor assembly mounted on rubber grommets.
  4. Filter: Removable, washable return air filter with anti-fungal treatment.
  5. Coil: Direct expansion type constructed from copper tubes expanded into aluminum fins. Tubes with internal grooves, factory pressure tested and factory charged with dry nitrogen. Include condensate pan below coil constructed of expanded polystyrene resin below coil and condensate pump.
- F. Controls: Provide with BACnet Server Gateway central control panel to allow BACnet IP interface to the building DDC system. Refer to DDC system control diagrams for control point mapping requirements.
- G. Manufacturers: Daikin, Samsung, LG Electronics Multi V™ IV Series, or approved.

#### 2.04 VARIABLE REFRIGERANT FLOW (VRF) HEAT PUMP

- A. Description: Variable capacity heat pump system utilizing variable refrigerant flow and operating on R-410a. Outdoor unit with direct expansion (DX) air-cooled heat pump system with variable speed driven compressor.
- B. Outdoor Unit:
1. Description: Factory assembled, piped, and wired with electronic and refrigerant controls. Factory run tested. Designed to operate:
    - a. In Heating Mode: Down to minus 13 F outdoor air temperature and up to 61 F outdoor wet bulb temperature.
    - b. In Cooling Mode: Down to 14 F and up to 122 F outdoor air temperature.
  2. Cabinet: Galvanized steel plate, bonderized with baked enamel finish.
  3. Refrigerant Circuits Include refrigerant strainer, check valves, oil separator, accumulator, four way reversing valve, electronic expansion valves, high pressure and low pressure refrigerant charging ports, high pressure safety switch, service valves, interconnecting piping, and oil injection mechanism. Include subcooling heat exchanger.
  4. Compressors: Inverter controlled hermetic scroll compressors. Each compressor with crankcase heater, internal thermal overloads, and vibration isolators.
  5. Unit Controls: Include control boards to operate VRF system and communicate with the HRU integration control panel.

6. Fan and Motor: Propeller type, vertical discharge, direct drive, variable speed fan motors. Motors with inherent protection and permanently lubricated bearings, variable speed, and fan guard.
7. Condenser Coil: Aluminum fins on copper tubing. Fins with corrosion resistant material with hydrophilic coating. Include integral metal guard.

C. Manufacturers: Daikin, Samsung, LG Electronics Multi V™ IV Series, or approved.

#### 2.05 REFRIGERANT PIPING FOR DUCTLESS SPLIT HEAT PUMP AND VRF SYSTEMS

- A. Pipe: Copper, Type ACR soft drawn, pre-charged, ASTM B 280, cleaned and dehydrated for refrigeration service with ends capped and sealed, 700 psig working pressure rating. Mueller Streamline® Co. or approved.
- B. Insulation: Closed cell elastomeric foam, factory pre-insulated, 1 inch thickness, meeting ASTM C 534 and ASTM E 84, UL listed and labeled with flame spread rating not greater than 25 and smoke developed rating not greater than 50.
- C. Ball Valves: Full port, two piece forged brass body with Teflon® ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals. Include Schrader ports. Maximum working pressure 500 psig and maximum temperature 300 F. Superior Valve Company, Parker Hannifin Corporation, Henry Technologies, or approved.
- D. Pipe Supports: Fabricated sheet metal pan as indicated on the Drawings.

#### 2.06 SOURCE QUALITY CONTROL

- A. Perform function test of packaged HVAC equipment before shipping.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

- B. Coordination: Coordinate required electrical and control installation work with Division 26 and Section 230900.

### 3.04 WORK PRIOR TO INSTALLATION

- A. Equipment manufacturer's authorized representative shall maintain personnel within 50 mile radius of job site. Representative capable of troubleshooting packaged HVAC equipment faults.
  - 1. Include 1 man day to meet with mechanical, electrical and control subcontractors and mechanical engineer at job site. Schedule this meeting within 1 week after equipment is delivered to final location at job site but prior to equipment installation. Purpose is to ensure that all parties understand what interconnections are required.
  - 2. After equipment installation, include 1 man day to assist control and electrical subcontractors in termination of interconnecting wires in unit mounted control panels. This service shall also verify proper connection and polarity of wires.

### 3.05 INSTALLATION OF PACKAGED HVAC EQUIPMENT AND COMPONENTS

- A. Install equipment with clearances for service and maintenance.
- B. Repair damaged condenser coil fins.
- C. Coordinate with Division 26 to install disconnects so as not to interfere with unit and internal component access and filters.
- D. Roof Mounted Equipment: Attach roof curbs to roof and mount units on roof curbs. Comply with requirements in Section 230548 for vibration isolators and Section 230550 for seismic restraints. Refer to architectural drawings for roof and roof insulation requirements.

### 3.06 INSTALLATION OF DUCTLESS SPLIT HEAT PUMP AND VRF SYSTEMS

- A. General: Install equipment level and plumb using manufacturer's standard mounting devices.
- B. Install equipment with clearances for service and maintenance.
- C. Install ball valves for zoned refrigerant isolation of each indoor unit and condensing unit.
- D. Install pipe supports in accordance with MSS SP-58, MSS SP-69, and Section 232116, whichever is more stringent.

### 3.07 START-UP SERVICES

- A. Equipment manufacturer's authorized representative shall perform start-up services of packaged HVAC equipment and related appurtenances. Services shall include check of proper installation, system check-out, adjustment, and complete start-up. Start-up by the Contractor not acceptable.
- B. Coordinate start-up services with air distribution system operation as specified in Division 01 and Section 230500 and TAB work specified in Section 230593.

### 3.08 HVAC SYSTEMS TRAINING

- A. Comply with requirements in Section 230810.

3.09 **COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*

**SECTION 23 82 00  
TERMINAL HEAT TRANSFER EQUIPMENT**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The Work includes unit heaters and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Applicable energy code.
  - 2. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

**1.03 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 230500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for the following:
  - 1. Unit heaters, electric.
  - 2. Blank copy of start-up and test report forms.
- C. Test Reports:
  - 1. Start-up and test reports.
  - 2. Submit completed copy of reports and include in the Operations and Maintenance Manual.

**PART 2 - PRODUCTS**

**2.01 UNIT HEATERS, ELECTRIC**

- A. Description: Unit heater consisting of casing, propeller fan, electric heating elements, and discharge assembly. Horizontal discharge.
- B. Casing: Steel die-formed construction with hinged access door.
- C. Fan: Propeller type, direct drive.

- D. Motor: Totally enclosed permanent split capacitor type with permanently lubricated sealed bearings. Comply with requirements in Section 230513.
- E. Electric Heating Element: High mass, steel, tubular finned type.
- F. Wiring: Single circuit with elements, motor, and control circuit subdivided with factory wired and fuses to conform to NEC and UL. Automatic reset thermal overloads and primary fusing for elements, motors, and transformers.
- G. Controls: Factory installed and wired contactors and control circuit transformer. Built-in fan override switch.
- H. Discharge: Multiple adjustable steel louvers.
- I. Components:
  - 1. Wall mounted low voltage thermostat with 45 to 90 F range.
  - 2. Wall mounted low voltage summer-fan switch.
  - 3. Mounting bracket and dust shield.
- J. Manufacturers: Modine Manufacturing Company, Trane® Model UHEC Series, Markel Products Company, Jaga, Electromode, Berko, Daikin, Brasch Manufacturing Company, Qmark, Redd-I Manufacturing Co, or approved.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive the Work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing the Work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from the Work of this section.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the Work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Coordinate required electrical and control installation work with Division 26 and Section 230900.

#### 3.04 CLEANING

- A. Clean enclosures and exposed piping.

- B. Clean inside and outside of cabinets prior to completion of work.

3.05 **HVAC SYSTEMS TRAINING**

- A. Comply with requirements in Section 230810.

3.06 **COMMISSIONING**

- A. Equipment and systems referenced in this section shall be commissioned per Section 230800. The Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation.

\*\*\*END OF SECTION\*\*\*



**SECTION 26 05 00  
GENERAL ELECTRICAL PROVISIONS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing and operation of electrical work. This section applies to all Divisions 26, 27, and 28 sections.
- B. General Requirements: General Conditions, Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 CODES AND STANDARDS**

- A. Perform work in accordance with requirements of the state in which the work is performed.
- B. Conform to applicable industry standards, UL standards, NEMA standards, and other standards as noted.
  - 1. Notify the A/E of deviations in Contract Documents to applicable codes and ordinances prior to installation of the Work. Perform changes in the Work after initial installation due to requirements of code enforcing agencies at no additional cost to the Owner.
  - 2. If conflict occurs between legally adopted codes and the Contract Documents, the codes prevail, except that this shall not be construed as relieving the Contractor from complying with requirements of the Contract Documents which may exceed code requirements and not contrary to same.
- C. Operating Conditions:
  - 1. Temperature: Minus 20 deg C to plus 40 deg C.
  - 2. Altitude: Up to 3,300 feet (1,000 meters).

**1.04 PERMIT INFORMATION**

- A. Permit Application: Arrange for and pay for all required permits, fees, and inspections required for work included in Division 26, 27, and 28.
- B. Permit Submittal Plan Review: Submit the following to the AHJ as required to support the permit application:
  - 1. Electrical Permit: Submit bid documents
  - 2. Fire Alarm Permit: Submit Shop drawings

1.05 SUBMITTALS

- A. Comply with requirements in Division 01 and with additional requirements indicated in this article.
- B. Electronic Product Data:
1. Comply with requirements in Section 013300 and additional requirements indicated in this article.
  2. Submit each specification section complete at one time with a dedicated submittal number for each section. For example, submit products for Section 260519 under one submittal number and products for Section 260533 under a different submittal number. Submitting multiple sections at one time acceptable as long as each section has a dedicated submittal number. Include submittal number and date submitted in file name.
  3. Submit signed letter indicating 3D model coordination has started and will continue through construction. 3D model not required to be submitted/reviewed during construction phase.
  4. Partial product submittals not acceptable and will be returned without review except as follows:
    - a. Section 260573 Power Studies including representative one-line diagram of distribution system (with bus numbers as described herein) indicating which devices will be presented in protective device coordination study and indicate additional information required to complete the study.
    - b. Section 260923 Lighting Controls including products and materials for first submittal and Shop Drawings for second submittal.
    - c. Sections 265100 Lighting including products and materials for first submittal and Shop Drawings for second submittal.
    - d. Section 283111 Fire Alarm and Detection Systems including products and materials for first submittal and Shop Drawings for second submittal.
    - e. Long lead items.
    - f. Site and underground work.
  5. Clearly mark catalog pages, equipment, and model number to be used. Indicate associated specification section and paragraph number on each page. Identify required options and accessories.
  6. Format:
    - a. Adobe PDF file format.
    - b. Bookmark each submittal to facilitate browsing to each specification paragraph number.
    - c. Include table of contents for each specification section. Include catalog numbers or drawing numbers.
    - d. Include the Contractor and manufacturer's representative contact information for each product. Include job name (or abbreviation of job name), specification number, and contractor submittal number in file name.
- C. Shop Drawings:
1. Submit as specified in the individual specification sections and this section. Submit minimum 30 days prior to starting fabrication on installation work. Do not fabricate on install until reviewed by the A/E. Include complete location dimensions, and hanger and support sizes and dimensions.

2. Provide dimensioned shop drawing of each electrical room with scaled equipment layouts that are based on the actual proposed equipment. Include code required clearance boundary on shop drawings. Include architectural elements and all equipment and system locations of other trades within rooms.
  3. "Typical" drawings and wiring diagrams not accepted unless they specifically apply to this project.
  4. Drawings shall be drawn at sufficient scale to show details clearly on same size sheets as Drawings.
  5. Show required coordination with work of other trades.
  6. Identify details and show their locations in Project.
  7. Include description of configuration and operation of proposed systems.
  8. Include outline drawings of proposed equipment in plan and elevation views including overall dimensions, weights, and clearance required.
  9. Include one-line electrical diagrams required for control and sensing.
  10. Floor plan backgrounds are available in electronic format and shall be requested from the A/E.
  11. Direct use of the Drawings as the basis of Contractor's prepared Shop Drawings not acceptable.
  12. Format:
    - a. Adobe PDF file format.
- D. Approval: Approval of a manufacturer's name or product by the A/E does not relieve the Contractor of the responsibility for providing materials and equipment which comply in detail with requirements of the Contract Documents.
- E. As-Built Drawings: Daily updates and markups that reflect all changes made in the specifications and working drawings during the construction process, and show the exact dimensions, geometry, and location of all elements of the work completed under the contract.
- F. Re-Submittals: Clearly identify re-submittals. Provide revised tabs, indexes, page renumbering, and other formats to interface with original submittal. Identify changes and include date for project tracking.
- G. Test reports and Certificates: Submit as a package prior to Substantial Completion.
- H. Certifications: Submit written certifications from the governing building authorities stating that work has been inspected and accepted and complies with applicable codes and ordinances.
- I. Record Drawings: Conformed set of as-builts developed during the construction process. Drawings shall be a single digital copy for each sheet in the contract documents and developed at the end of the construction phase. Comply with Article "Record Drawings" in this section.
- J. Schedule of Values:
  1. Comply with the requirements in Division 01 with additional requirements as indicated in this paragraph.
  2. Include costs in Schedule of Values as follows:
    - a. Mobilization.
    - b. Submittals.
    - c. Electrical Permit.

- d. 3D Coordination
- e. Electrical Site – Utility Provisions, Material.
- f. Electrical Site – Utility Provisions, Labor.
- g. Electrical Site – Site Lighting Rough In, Material.
- h. Electrical Site – Site Lighting Rough In, Labor.
- i. Electrical Site – Power and Low Voltage, Material.
- j. Electrical Site – Power and Low Voltage, Labor.
- k. Lighting Systems – Fixtures & Lamps Material.
- l. Lighting Systems – Fixtures & Lamps Labor.
- m. Lighting Systems – Branch Circuit Raceway Rough-in, Material.
- n. Lighting Systems – Branch Circuit Raceway Rough-in, Labor.
- o. Lighting Systems – Branch Circuit Wiring, Material.
- p. Lighting Systems – Branch Circuit Wiring Labor.
- q. Lighting Systems – Devices & Trim, Material.
- r. Lighting Systems – Devices & Trim, Labor.
- s. Power Systems – Switchgear, Disconnects, Material.
- t. Power Systems – Switchgear, Disconnects, Labor.
- u. Power Systems – Generator, Transfer Switch, Load Bank, Material.
- v. Power Systems – Generator, Transfer Switch, Load Bank, Labor.
- w. Power Systems – Feeder Raceway Rough-in, Material.
- x. Power Systems – Feeder Raceway Rough-in, Labor.
- y. Power Systems – Feeder Conductor, Material.
- z. Power Systems – Feeder Conductor, Labor.
- aa. Power Systems – Equipment Connections.
- bb. Power Systems – Branch Circuit Raceway Rough-in, Material.
- cc. Power Systems – Branch Circuit Raceway Rough-in, Labor.
- dd. Power Systems – Branch Circuit Wiring, Material.
- ee. Power Systems – Branch Circuit Wiring, Labor.
- ff. Power Systems – Devices & Trim, Material.
- gg. Power Systems – Devices & Trim, Labor.
- hh. Low Voltage – Fire Alarm Rough-in, Material.
- ii. Low Voltage – Fire Alarm Rough-in, Labor.
- jj. Low Voltage – Fire Alarm Trim, Material.
- kk. Low Voltage – Fire Alarm Trim, Labor.
- ll. Low Voltage – Telecommunications Pathway Rough-in, Material.
- mm. Low Voltage – Telecommunications Pathway Rough-in, Labor.
- nn. Low Voltage – Telecommunications Cabling, Material.
- oo. Low Voltage – Telecommunications Cabling, Labor.
- pp. Low Voltage – Intrusion Detection, Material.
- qq. Low Voltage – Intrusion Detection, Labor.
- rr. Low Voltage – Access Control, Material.
- ss. Low Voltage – Access Control, Labor.
- tt. Low Voltage – Security Video, Material.
- uu. Low Voltage – Security Video, Labor.
- vv. Punch List and Close Out.
- ww. Testing Commissioning and Training.

#### 1.06 DEFINITIONS AND ABBREVIATIONS

- A. Refer to Division 01 for definitions and abbreviations. Additional definitions and abbreviations are as follows.
- B. “Approved” or “Approval” means written approval by the Owner or “Owner’s agent” (A/E).

- C. “Codes” means AHJ adopted codes, rules, and ordinances and additional codes as specified herein.
- D. “Concealed” means spaces out of sight. For example, above ceilings, below floors, between double walls, furred-in areas, pipe and duct shafts, and similar spaces.
- E. The word “Contractor”, as used in Divisions 26, 27, and 28 sections, means the electrical subcontractor.
- F. “Coordination”, “Coordinating”, and “Coordinate” means to bring, or the bringing, into a common action, movement, or combination so as to act together in a smooth concerted way.
- G. “Directed”, “Requested”, “Accepted”, and Similar Terms means these terms imply “by the A/E” unless otherwise indicated.
- H. “Exposed” means open to view. For example, raceways installed in a tunnel or raceways installed in a room and not covered by other construction.
- I. “Furnish” means supply and deliver to the project site ready for unloading, unpacking, assembly, installation, and similar activities.
- J. “Indicated” and “Indicated on the Drawings” means shown on Drawings by notes, graphics or schedules, or written into other portions of Contract Documents. Terms such as “shown”, “noted”, “scheduled” and “specified” have same meanings as “indicated”, and are used to assist the reader in locating particular information.
- K. “Install” means to place in position for service or use. Includes operations at project site, such as unloading, unpacking, assembly, erection, placing, preserving, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar activities.
- L. “Provide” means furnish and install for a complete, finished, and operable system and ready for intended use.
- M. “Shop Drawings” means Document which fully details equipment and intended installation relative to this specific Project.
- N. “Structural Members” means all above and below grade elements associated with the structural support of the building or structure.
- O. “Substantial Completion” shall mean that the entire project (or readily definable portion thereof if so designated in the Contracted Documents) is acceptable to code enforcement authorities and to extent required by such authorities, has been inspected and approved by such authorities, and is suitable for occupancy by the Owner or occupant for the purpose intended. Refer to Divisions 00 and 01 for additional requirements.
- P. “Work” or “Project” means entire scope of work required by the Contract Documents.
- Q. Abbreviations:  
A/E            Owner  
ADS            Acoustical Distinguishable Space  
AFCI           Arc Fault Circuit Interrupter  
AHJ            Authorities Having Jurisdiction  
ANSI           American National Standards Institute  
ASTM           American Society for Testing and Materials

ATP	Acceptance Test Procedure
BMS	Building Management System
BOM	Bill-of-Material
C	Degrees Celsius
CCT	Correlated Color Temperature
CIS	Common Intelligibility Scale
CSA	Canadian Standards Association
CR	Controlled Receptacle
CRI	Color Rendering Index
CU	Coefficient of Utilization
DAS	Distributed Antenna System
EBS	Educational Broadband Service
EMS	Energy Management System
EMT	Electrical Metallic Tubing
EPO	Emergency Power Off
ETL	Environmental Technology Laboratory
EUSERC	Electric Utility Service Equipment Requirements
F	Degrees Fahrenheit
FC	Foot-candle
FM	Factory Mutual Engineering Corporation
GB	Ground Fault Circuit Interrupter Breaker
GFCI	Ground Fault Circuit Interrupter
GFI	Ground Fault Circuit Interrupter
GUI	Graphical User Interface
HDPE	High-density polyethylene
HID	High-intensity discharge
HVAC	Heating, Ventilation and Air Conditioning
IC	Insulation contact
IBC	International Building Code
IDF	Intermediate distribution frame
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineering
IES	Illuminating Engineering Society
IMC	Intermediate Metal Conduit
K	Kelvin
kVA	Kilo Volt Amps
LED	Light-emitting diode
LPI	Lightning Protection Institute
MC	Metal Clad
MDF	Main distribution frame
NEC	National Electrical Code, NFPA 70 (latest adopted edition with Amendments)
NEMA	National Electrical Manufacturer's Association
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Test Laboratory
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyl
PDU	Power Distribution Units
PF	Power factor
RMC	Rigid Metal Conduit
RMS	Root Mean Square
RTRC	Reinforced thermosetting resin conduit
SCCR	Short Circuit Current Rating
SPD	Surge Protective Devices
STC	Factory Standard Test Condition
STI	Sound transmission index
STIPA	STI for public address systems

TCLP	Toxicity characteristic leaching procedure
THD	Total Harmonic Distortion
TIA	Telecommunications Industry Association
UL	Underwriters Laboratories Inc.
UPS	Uninterruptible Power Supply
V	Volts
VOIP	Voice Over Internet Protocol
VRLA	Valve Regulated Lead Acid Batteries

#### 1.07 MATERIALS

- A. Where two or more manufacturers are listed, select for use any of those listed. The first mentioned, in general, was used as the basis of design. Bids on any manufacturer named acceptable as long as that manufacturer meets every aspect of the Contract Documents. Note that equipment layout is based on equipment listed in equipment schedules.
- B. Ensure that equipment will fit within available space. Where other than basis of design manufacturer is selected for the Project, the Contractor is responsible for verifying equipment will fit within available space and meet manufacturers and code required clearances.
- C. Where other than basis of design manufacturer is selected for the Project, include cost of resulting additional work, coordination with other trades, and redesign of associated building services and structure as required to accommodate selected equipment. Include redesign drawings with submitted Shop Drawings.

#### 1.08 STANDARDS OF QUALITY

- A. Materials and Equipment: UL listed and labeled or other AHJ approved testing laboratory and in compliance with other industry standards as specified.
- B. Equipment shall be manufacture's regularly catalogued items and shall be supplied as a complete unit in accordance with manufacturer's standard specifications and any optional items required for proper installation for equipment unless otherwise noted. Equipment and materials shall be installed in accordance with the manufacturer's recommendations and best trade practices.
- C. Products shall be new unless indicated otherwise in the Contract Documents.
- D. Fabricator and Manufacturer Qualifications: Specialists with at least 5 years' experience and regularly engaged in manufacture of equipment and materials specified.
- E. Furnish products of a single manufacturer for items which are used in quantity. A Product, for the purpose of this paragraph, is an assembly of components such as switchboards, transformers, panelboards, and similar items. Materials such as wire and cable, raceways, outlet boxes, and similar items not requiring maintenance are not included in the single manufacturer requirement of this paragraph.
- F. Installer Qualifications: Specialists with at least 5 years' experience and regularly engaged in the installation of the system, equipment, and materials specified. Where required by the AHJ, employ licensed trades persons.

#### 1.09 SUBSTITUTIONS

- A. Comply with requirements in Division 01 with additional requirements indicated in this article.

- B. Substitutions will be considered following bid award only when a product becomes unavailable through no fault of the Contractor.
- C. Where “Manufacturer” paragraphs include the words "or approved", prior approval of the proposed substitution is required. The A/E is sole judge of quality of proposed substitution.
- D. When the A/E approves a substitution request, the approval is given with the understanding that the Bidder:
  - 1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
  - 2. Will provide the same warranty for the Substitution as for the specified Product.
  - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
  - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
- E. Whenever a Product is described by detail, specification, trade name, manufacturer's name or catalog reference, use only such Product unless written approval is given for substitution prior to bid. Submit written requests on substitution request form included in Division 01. Approved substituted manufacturers will be listed by Addendum.
- F. Provide as specified certain products, materials, and systems where “manufacturer” paragraphs are followed by the words “no substitutions”.
- G. Substitutions will not be considered when they are indicated or implied on Shop Drawings or product data submittals, without separate written prior approval, or when approval will require revision to the Contract Documents.

#### 1.10 DRAWINGS AND SPECIFICATIONS

- A. General: The electrical drawings are diagrammatic. Complete details of building features which affect electrical installation may not be shown. For additional details, refer to other Contract Documents. Report any discrepancies to the A/E along with suggested revisions. Obtain written response from the A/E before proceeding with changes.
- B. Depiction of Work: Drawings do not show the exact characteristics of the work including, physical arrangement of equipment, lengths of wiring or conduit runs. Base work on actual field measurements and conditions. Provide work required to complete the installation.
- C. Dimensions: Do not scale drawings. Dimensional accuracy is not guaranteed, and field verification of dimensions, locations, and levels to suit field conditions is required.
- D. Since the Drawings of floor, wall, and ceiling installation are made at small scale, outlets, devices, equipment, and similar items are indicated only in their approximate location. Locate outlets and apparatus symmetrically on floors, walls, and ceilings where not dimensioned and coordinate such locations with work of other trades to prevent interferences.



- E. Discrepancies: Field verify dimensions and existing conditions prior to performing work. Bring to the A/E's attention any discrepancies within the Contract Documents and between the Contract Documents and field conditions. Also, for any design and layout changes required due to specific equipment selection, prior to the Contractor's work (equipment and material purchasing and installation). Any corrective work required by the Contractor after his discovery of such discrepancies, inconsistencies, or ambiguities shall be at no additional cost to the Owner.
- F. Specifications: These specifications are written in imperative mood and streamlined form. The imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

#### 1.11 RECORD DRAWINGS

- A. Comply with requirements in Division 01, with additional requirements as indicated in this article.
- B. Prepare As-Built drawings: As-Built Drawings shall be red line prints in digital or hand drawn format (pencil and black pen not acceptable).
  - 1. Corrections and Changes: Record during the progress of the Work, showing work as actually installed.
    - a. Show the measured locations of portions of the Work and changes the Contractor has made.
    - b. In general, tolerance plus or minus 1'-0" from actual location.
    - c. Show addendum items, change orders, clarifications, supplemental instructions, and deviations from the Drawings. Show device or equipment changes and indicate where the change was originated. Only indicating the document where the change originated from will not be accepted.
  - 2. Updates: Neatly hand-draft on daily basis and kept readily available at project site. Updates are subject to review by the A/E on a regular basis throughout construction. Updates are to include the following at a minimum:
    - a. Feeder routing indicating upstream and downstream equipment.
    - b. Installation locations for underground raceways and where they transition to above grade.
    - c. Device locations and mounting heights.
    - d. Junction and pull boxes with two or more home runs.
    - e. Junction and pull boxes with one home run.
    - f. Circuit information.
    - g. Shop Drawings: Update shop drawings with changes or deviations from the Original Shop Drawings. Provide updates to manufacturer/vendor for inclusion in Record Drawings.
- C. Record Drawings: Develop a digital set of Record Drawings for the project utilizing the as-built drawings. Digital Record Drawings can be in AutoCAD or PDF format. At end of construction, check drawings for completeness and accuracy.
- D. Shop Drawing Record Drawings: Provide updated shop drawings based on As-Built drawings for use as Record Drawings.

- E. Per project closeout procedures, submit in Digital Record Drawings and a copy of the As-Builts. Each sheet shall be noted as "RECORD DRAWING".

**1.12 COORDINATION**

- A. Coordinate Divisions 26, 27, and 28 work with other trades.
- B. Be aware of restricted space for installation of electrical systems. Include offsets and perform rerouting and coordination to fit elements in available space. Include provisions for such requirements in bid.
- C. Electrical equipment and systems shown are based on existing drawings as available and on limited project site observations to the extent possible under current conditions. Field verify existing conditions prior to commencement of work. Obtain specific locations of structural and architectural features or equipment items from referenced drawings, field measurements, or trade providing material or equipment.
- D. Coordinate raceway installations to clear light fixtures and electrical cable trays. Include clearance over light fixtures to allow removal and replacement. Include minimum 6 inch clearance above and to sides of cable trays.
- E. Be responsible for beam penetrations as they relate to the electrical work. Submit sizes and locations to the structural Engineer for review and determination of structural details.
- F. Coordinate attachments to structure to verify that attachment points on equipment and structure can accept seismic, weight, and other loads imposed.

**1.13 WORKMANSHIP**

- A. Work shall be in accordance with best trade practices. Remove substandard workmanship and provide new material at no extra cost to the Owner.

**1.14 CERTIFICATION**

- A. By submitting a bid for the electrical, telecommunications, electronic safety and security systems, the Contractor and his subcontractors acknowledge and certify the following:
  - 1. That they have carefully examined and fully understand the Drawings and Specifications (including but not limited to architectural, site, utility, mechanical, structural and electrical drawings and specifications. In addition, they have determined that the Drawings and Specifications are adequate to complete the electrical systems and that they can provide a complete finished and operable system in accordance with the Contract Documents.
  - 2. That they have had a reasonable opportunity to discover any ambiguities in the Contract Documents and such ambiguities have been brought to the attention of the A/E in writing prior to submitting the bid.
  - 3. That they have reviewed the project progress schedule with the general contractor, fully understand the schedule, and they have verified, prior to submitting a bid, availability of necessary labor and materials, including supervision and office backup, and can comply with the schedule requirements.

4. That there may be changes to the scope of work and that they understand that any proposal submitted for performance of additional work shall include costs associated with such change including but not limited to labor, materials, subcontracts, equipment, taxes, fees, schedule impact, loss of efficiency, supervision, overhead and profit.
5. That the Contract requires them to coordinate their work with that of other trades and that responsibility for coordination includes rerouting, offsets, and similar provisions, to fit Work and address manufacturer's recommended clearances for service access, maintenance, and replacement of equipment in a manner that is compatible with work of other trades in the same area.
6. That routing of elements of electrical systems shown on the Drawings is schematic only and that offsets and rerouting probably will be required in installation and that labor and materials have been included for such in their bids.
7. That they understand submittals of material and equipment to the A/E is for the purpose of establishing what they are providing for the project. Any review undertaken by the A/E does not relieve them of their responsibilities to furnish and install materials and equipment required for work in the project nor does such review relieve them of their responsibilities for coordination with other trades and designers to ensure that such materials and equipment will fit and be suitable for purpose intended.
8. That they agree to receive payment for bid amounts as full compensation for furnishing materials and labor which may be required in prosecution and completion of work required under the Contract Documents, and in respects to complete the contract work to the satisfaction of the A/E.
9. That they include in their bids costs to furnish bonds as specified in the Contract Documents.

**1.15 WARRANTY**

- A. Conform to requirements in General Conditions, Supplementary Conditions, and Division 01. Where not so prescribed or defined, the period shall be 1 year. Warranty periods within Divisions 26, 27, and 28 shall not commence until final acceptance. Contractor shall extend longer warranties specified in other sections.

**1.16 EQUIPMENT FURNISHED BY OWNER INSTALLED BY CONTRACTOR (OFIC)**

- A. **Material Handling and Delivery:** Coordinate delivery of OFIC equipment. Receive, off load, transport, store, hoist, unpack, dispose of packing, same as for other project equipment arriving at job site. Requirements of the Contract Documents apply to OFIC equipment.
- B. **Operation and Maintenance Data:** Obtain from the Owner operation and maintenance data for the OFIC equipment and incorporate them into the Operations and Maintenance Manuals.
- C. **Start-up and Warranty:**
  1. OFIC equipment suppliers will pass on to the Contractor start-up information, maintenance and parts information, and warranty provisions of their products in accordance with the equipment suppliers contract requirements. Organize and coordinate start-up and warranty requirements for the OFIC equipment.
  2. Include one year warranty on OFIC equipment starting at substantial completion regardless of shorter time limits by OFIC suppliers.

**1.17 DEMONSTRATION**

- A. Comply with requirements in Division 01 with additional requirements indicated in this article.
- B. Following installation of electrical work and prior to final acceptance, demonstrate that equipment and systems operate as indicated in the Contract Documents and in accordance with manufacturer's recommendations.
- C. Perform in presence of the A/E and Owner's representative, unless otherwise directed by the A/E. Give minimum 1 week notice prior to demonstrations.
- D. Provide instruments and personnel required to conduct demonstrations.

**1.18 SUBSTANTIAL COMPLETION**

- A. Comply with requirements in Division 01.
- B. Prepare list of items that are not complete prior to asking for a substantial completion review by the A/E.

**1.19 ALTERNATES**

- A. General: See Bid Form and Alternates described in Division 01 for possible effect on work of Divisions 26, 27, and 28.

**1.20 OPERATION AND MAINTENANCE MANUALS**

- A. Prepare Operation and Maintenance Manuals for equipment and materials furnished under Divisions 26, 27, and 28.
- B. Comply with requirements in Division 01 with additional requirements indicated in this article.
- C. Submit one hard copy and one electronic PDF format of Operation and Maintenance Manuals for review at least 4 weeks prior to Substantial Completion date. Assemble hard copy Operation and Maintenance Manual in 3-ring binder(s). Comply with requirements listed in Division 01 77 00. Separate binders for each category, such as Electrical, Telecommunications, and Electronic Safety and Security. Where one subject matter encompasses more than one binder, differentiate by volume numbers. Include indexed tabs for each binder. Engrave cover with the project title in 1/2 inch high letters and name and address of the Contractor in 1/4 inch high letters. Provide same information in 1/8 inch high letters on spine.
- D. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Include serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, and similar information. Each item of equipment shall have its own individual sheet. (Example: If 2 items of equipment A and D appear on the same sheet, individual sheet shall be included for each unit specified.)
- E. Include the Following Information:
  - 1. Identifying name and mark number.
  - 2. Certified outline drawings and Shop Drawings.
  - 3. Parts list.
  - 4. Performance curves and data.

5. Wiring diagrams.
6. Manufacturer's recommended operating and maintenance instructions.
7. Vendor's name, address and telephone number for all parts and equipment.
8. Name, address and telephone number of Contractor performing the work.
9. Test reports.
10. Product data and Record Drawings.

**1.21 TESTING**

- A. Comply with requirements in Section 260810.

**1.22 PROJECT TRAINING**

- A. Upon completion and testing of equipment and system installation, assemble equipment factory representatives and subcontractors for system training with Owner's representatives as required in specific specification sections.
- B. Each representative and subcontractor shall assist in start-up, check out, and training for their respective system and remain on-site until the total system operation is thoroughly reviewed by the Owner's representatives and are thoroughly trained. Return for additional training sessions as required to completely train Owner's Representatives.
- C. Factory representative and system subcontractor shall give personal instruction on operating and maintenance of their equipment to the Owner's maintenance and operation personnel. To certify acceptance of operation and instruction by the Owner's representative, prepare a written statement as follows:
1. This is to certify that the factory representative and system subcontractor for each system listed below have performed start-up and final check out of their respective systems.
  2. The Owner's maintenance and operation personnel have received complete and thorough instruction in the operation and maintenance of each system.

SYSTEM

FACTORY REPRESENTATIVE

---

(List systems included) (List name and address of factory representative.)

---

Owner's Representative                      Contractor

- D. Submit copy of acceptance to A/E.

**1.23 PUNCHLIST AND FINAL REVIEWS**

- A. At the time of punchlist and final reviews, the project electrical foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested to allow review of entire electrical system.
- B. Punch List: Review each punch list item; update field conditions to address items or provide comment response for reason the item has not been addressed in the field.

1.24 **COMMISSIONING SUPPORT**

- A. Comply with requirements in Sections 019113 and 260800.
- B. Selected Division 26 equipment and systems referenced are to be commissioned per Section 019113 – General Commissioning Requirements and Section 260800 – Commissioning of Electrical Systems. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 05 10**  
**BASIC ELECTRICAL MATERIALS AND METHODS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes basic electrical requirements specifically applicable to Divisions 26, 27, and 28 sections including general material and installation requirements and site work.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to the Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. UL Compliance: Where UL fire-resistance rating is indicated for construction penetrated by access units, furnish UL listed and labeled units, except for those units which are smaller than minimum size requiring ratings as recognized by governing authority.
- C. Codes and Standards:
  - 1. ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>).

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products in accordance with manufacturer's recommendations, using means and methods to prevent damage, deterioration, and loss, including theft.
- B. Deliver products to site in manufacturer's original containers, complete with labels.
- C. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
- D. Store products subject to damage by weather conditions above ground, under cover in weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

PART 2 - PRODUCTS

2.01 **GENERAL**

- A. Furnish specified items acceptable to AHJ as suitable for intended use.
- B. New, unless otherwise indicated, free from defects and the standard products of reputable manufacturers regularly engaged in production of such equipment.
- C. Furnish similar items of equipment by same manufacturer.
- D. Materials and Equipment: UL listed and labeled or other AHJ approved testing laboratory and in compliance with other industry standards as specified.
- E. Remove rejected or damaged material from site.
- F. Samples may be required for non-standard or substituted items before installation. Submit samples as required in specific specification sections.
- G. Furnish required items necessary for installation and testing procedures.

2.02 **POSTED INSTRUCTIONS**

- A. Posted Operating Instructions: Furnish simplified, consolidated equipment control and power diagrams. Graphically represent entire system and actual equipment installed. Include concise written instructions on how to start and stop systems. Show settings and conditions to be observed. Indicate what control adjustments are to be made or maintained by the operator.
  - 1. Include control diagrams and specific operating instructions.
  - 2. Indicate how to energize each major component of systems. Show what action must be taken in an emergency, how to restore power following an outage, and what precautions to be taken when maintenance is required.
  - 3. Include photographic or comparable non-fading reproductions, either framed under glass or encased in non-discoloring plastic.
  - 4. Include one-line diagrams of electric power distribution riser.
- B. Copies of operating instructions shall be used with Operation and Maintenance Manuals as basis in training Owner's employees in the operation and maintenance of systems and related installed equipment.

2.03 **ENCLOSURES**

- A. NEMA Type 1 – Dry Interior locations unless otherwise noted on drawings or as specified below.
- B. NEMA 3R Weather-proof/Rain-proof – Windblown rain, sleet, ice – Provide in all locations where exposed to moisture unless otherwise noted.
- C. NEMA 4 – Water-tight/Rain-tight – Splashing and hose directed water, windblown dust, ice.
- D. NEMA 4X– Water-tight/Rain-tight – Splashing and hose directed water, windblown dust, ice, corrosion resistant.



- E. NEMA 12 - Dust-tight/Water-tight/Drip-tight - Circulating dust, falling dirt, dripping non-corrosive liquids.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify installation conditions as satisfactory to receive work of the various sections. Do not install until unsatisfactory conditions are corrected.

#### 3.02 INSPECTIONS

- A. Confirm that installations have been inspected before enclosure within building features, buried, or otherwise hidden from view. Pay costs associated with uncovering or exposing installations and features not previously inspected and for repair to exposed surfaces.

#### 3.03 PREPARATION

- A. Protect surrounding areas and surfaces to prevent damage as work is installed.
- B. Obtain equipment roughing-in dimensions from approved Shop Drawings or actual measurements.
- C. Be familiar with the location of other trade's equipment. Eliminate conflicts. Check door swings before installing switches. Locate switches on strike side of doors unless noted otherwise.
- D. Layout electrical, telecommunications, and electronic safety and security work in advance of construction to eliminate unnecessary cutting, drilling, channeling, and similar activities. Where such cutting, drilling, channeling and similar activities become necessary for proper installation, perform with care using skilled mechanics of trades involved. Repair damage to building and equipment at no additional cost to the Owner.
- E. Perform cutting work of other trades only with consent of that trade. Cutting structural members not permitted without consent of the A/E.

#### 3.04 INSTALLATION

- A. Install Work as specified and in accordance with the Drawings and manufacturer's instructions. Where these conflict, manufacturer's instructions govern.
- B. Review Architectural, Mechanical and other applicable drawings and applicable Shop Drawings to prevent switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, and similar items, or from being located in whiteboards, tackboards, glass panels, and similar items. Relocate electrical devices and connections as directed by the A/E at no additional cost to the Owner if the work is not properly coordinated.
- C. Where conduit, outlets, and apparatus are encased in concrete, locate and secure at point of installation. Check locations of electrical items before and after concrete and masonry installation and relocate displaced items.

- D. Provide block-outs, sleeves, demolition work, and similar items required for installation of Work specified in this division.

**3.05 WORKMANSHIP**

- A. Work and materials will be subject to observation at any time by the Owner and the A/E.
- B. Install material and equipment in accordance with manufacturer's instructions. Provide calibrated torque wrenches and screwdrivers as required.
- C. Cutting and Patching: Do not weld to, cut, or notch structural members or building surfaces without approval of the A/E. Restore surfaces neatly to original condition after cutting, channeling, chasing, and drilling of walls, partitions, ceilings, paving, and anchorage of conduit, raceways, and other electrical equipment.

**3.06 WELDING, CUTTING, AND DRILLING**

- A. Perform in accordance with American Welding Society Standards.

**3.07 EARTHWORK**

- A. Perform earthwork required for installation of electrical work below grade. Provide earthwork meeting requirements in this article and Division 31, whichever is most stringent. Provide earthwork meeting requirements of the serving utility company where earthwork is related to utility infrastructure.
- B. Locate and protect existing utilities and other underground work in manner which will ensure that no damage or service interruption will result from excavating and backfilling. Perform excavation in a manner which protects walls, footings, and other structural members from being disturbed or damaged in any way.
- C. Place and maintain barricades, warnings, construction signs, illumination and guards as required during periods of open excavation to protect persons from injury and to avoid property damage. Provide bracing and shoring as necessary to maintain stability of excavation and to comply with safety codes.
- D. Coordinate excavations with weather conditions to minimize possibility of washouts, settlements and other damages and hazards.
- E. Do not excavate until required materials are on site and the Work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimal. Refer to other sections for additional requirements for excavating.
- F. Store excavated material (temporarily) near excavation in manner which will not interfere with or damage excavation or other work.
- G. Retain excavated material which complies with requirements for backfill material. Dispose of excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site and dispose of in lawful manner.

- H. Backfill trenches only after observation by the A/E. Install backfill material under, around, and between conduit and sides of trench by hand, shovel tamped in place. Cover in 6 inch layers to 12 inch thickness over top of conduit or cabling. For final backfill, fill and tamp remainder of backfill material in 6 inch layers. Provide backfill materials as follows for buried conduit or cable (other than concrete encased):
1. Backfill below, on sides of, and over conduit or cable: Sand or pea gravel. Minimum thickness of 6 inches above, below and at sides of outer conduits. Minimum 3" spacing between conduits.
  2. Backfill to within 6 inches of Final Grade: Soil material suitable for compacting to required densities. Per Division 31 requirements.
  3. Backfill for top 6 Inches of excavation: Topsoil except where excavations occur below paved or gravel area provide compacted gravel backfill or surface area as indicated.
- I. Compacting:
1. Perform compacting individually, for each 6 inch layer (maximum) loose thickness of initial and final backfill. Comply with ASTM D 1557. Where roadway or parking area surfaces will be placed over backfill, and to 10 feet beyond building perimeter, compacted to 95 percent of maximum density. Elsewhere, 90 percent. Test in accordance with Divisions 1 and 31.
  2. Take special care in compacting under services where they enter building to prevent settling. Contractor fully responsible for damage to piping and property as a result of settling around service conduit and cabling.
- J. Subsidence: Where subsidence is measurable or observable at electrical work excavations during project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.

### 3.08 CONCRETE BASES

- A. Unless noted otherwise, provide 4 inch high reinforced concrete bases for floor mounted and floor standing electrical equipment, including generators, transformers, switchgear, battery racks, motor control centers, and similar equipment. Extend bases 4 inches beyond equipment or mounting rails in each direction unless noted otherwise on the Drawings.
- B. Concrete bases shall be provided under Division 26. Coordinate size and location of bases and provide required anchor bolts, sleeves, and templates required to obtain proper installation.
- C. Provide concrete pads and vaults for power company furnished pad mounted transformers in accordance with power company clearance requirements.

### 3.09 CLEANING

- A. Clean equipment, conduit, and fittings and remove packing cartons and other debris created by Divisions 26, 27, and 28 Work.
- B. Before Substantial Completion, carefully clean equipment, fixtures, exposed raceways and similar items. Remove construction labels, dirt, cuttings, paint, plaster, mortar, concrete, and similar items. Clean fixtures, interiors and exteriors of equipment and raceways.

3.10 IDENTIFICATION

- A. Provide nameplates and decals required to identify equipment and components, comply with requirements in Section 260553.
- B. Mount operating instructions and diagrams near equipment or elsewhere as otherwise designated by the Owner.

3.11 PROTECTION

- A. Protect equipment during and after electrical hookup, painting, and final testing.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 05 11**  
**ELECTRICAL CONNECTIONS FOR EQUIPMENT**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes final electrical connection to equipment having electrical requirements. Contractor shall make final connections for Owner furnished equipment including switches, receptacles, and similar items. See other applicable specification sections for building temperature control wiring requirements specified in Divisions 21, 22, and 23.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.
- C. Connection to Equipment Specified in Divisions 21, 22, and 23 as Follows unless Specified Otherwise in Divisions 21, 22, and 23:
  - 1. For motorized only equipment with built-in controllers (packaged equipment), Connect power and provide an external disconnect at equipment. Division 23 will provide control wiring.
  - 2. For motorized only equipment with external controller (non-packaged equipment), provide external motor controller, disconnect switch, and make power wiring complete to equipment. Division 23 will provide control wiring.
  - 3. For electric duct heaters with built-in controllers (packaged type equipment), connect power complete and provide external disconnect switch at equipment. Division 23 will provide control wiring.
  - 4. For electric duct heaters with remote controllers (non-packaged type equipment), provide external controller, disconnect switch, and make power wiring to equipment. Division 23 will provide control wiring.
  - 5. For combination motorized and electric heating packaged units specified with built in controllers and specified with "single point electrical connection" under Division 23, connect power and provide external disconnect switch. Division 23 will provide control wiring.
  - 6. For equipment requiring a full voltage non-reversing starter, include as a combination disconnect unit.
- D. Refer to Division 23 sections for control system wiring.
- E. Refer to sections of other divisions for specific individual equipment power requirements.
- F. Make final connection to kitchen equipment.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. NEC Compliance: Comply with applicable portions of NEC as to type of products used and installation of electrical power connections.
- C. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NEC for workmanship and installation requirements and to applicable Division 26 sections.
- D. UL Labels: Provide electrical connection products and materials which have been UL listed and labeled.

**PART 2 - PRODUCTS**

**2.01 ELECTRICAL CONNECTIONS MATERIALS**

- A. For each electrical connection indicated, include complete assembly of materials, including but not limited to, raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories to complete splices, terminations, and connections.
- B. Comply with requirements in Section 260519 for wires and cables, Section 260533 for raceway systems, and Section 262726 for wiring devices.
- C. Include Final Connections for Equipment Consistent with the Following:
  - 1. Permanently Installed Fixed Equipment: Flexible seal-tite conduit from branch circuit terminal equipment, and raceway to equipment, control cabinet, terminal junction box, and wiring terminals. Totally enclose wiring in raceway.
  - 2. Movable and/or Portable Equipment: Wiring device, cord cap, and multi-conductor cord suitable for equipment and in accordance with NEC requirements.
  - 3. Other methods as required by NEC and as required by special equipment and field conditions.

**PART 3 - EXECUTION**

**3.01 INSTALLATION OF ELECTRICAL CONNECTIONS**

- A. Make electrical connections in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.
- C. Coordinate installation of electrical connections for equipment with installed equipment.

- D. Verify electrical loads (voltage, phase, full load amperes, number and point of connections, minimum circuit ampacity, and similar characteristics) for equipment furnished under other divisions, by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics. Report variances from electrical characteristics noted on electrical drawings to the A/E before proceeding with rough-work.
- E. Obtain and review equipment submittals and shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.
- F. Comply with requirements in Section 260553 for identification of electrical power supply conductor terminations.

**3.02 STARTERS (CONTROLLERS)**

- A. Install non-packaged starters and wiring devices near motors or as indicated on the Drawings. Securely support and anchor in accordance with manufacturer's installation instructions. Locate for proper operational access, including visibility for safety.

**3.03 PROVISIONS FOR MECHANICAL CONTROLS**

- A. Provide 120 Volt, 20 Amp circuit at locations required and described in Section 230900. Coordinate exact locations prior to installation.
- B. Install power metering equipment at panelboards and switchboards furnished by control system subcontractor at locations required and described in Section 230900.

**3.04 EQUIPMENT SHORT CIRCUIT CURRENT RATING**

- A. All mechanical equipment, packaged systems, control panels, motor starters, motor controllers, variable frequency drives and similar equipment shall carry a Short Circuit Current Rating (SCCR) equal to or greater than the available fault current delivered from the electrical system. Coordinate final available fault currents with the contractors providing this equipment.

**3.05 MECHANICAL – ELECTRICAL INTERFACE SCHEDULE**

- A. Establishing the separation of work between trades and subcontractors is not within scope of these Contract Documents. The following schedule is proposed for assistance in bidding only.
- B. Unless otherwise indicated in the Contract Documents, mechanical equipment and controls are suggested to be furnished, installed, and wired in accordance with the following schedule. Coordinate work with Division 22 and 23 sections.

Item	Furnished By:	Installed By:	Power Wiring By:	Control Wiring By:
1. Equipment Motors:	M	M	E	M
2. Magnetic Motor Starters and Equipment Connections:				
a. Automatically Controlled with or without HOA Switches:	E	E	E	M
b. Manually Controlled:	E	E	E	E
c. Furnished with Mechanical Equipment, Factory Mounted:	M	M	E	M

SECTION 26 05 11  
ELECTRICAL CONNECTIONS FOR EQUIPMENT

Item	Furnished By:	Installed By:	Power Wiring By:	Control Wiring By:
d. Furnished with Mechanical Equipment, Field Mounted:	M	E	E	M
3. Disconnect Switches and 120 Volt Receptacles per IMC and NEC:	E	E	E	--
4. Manual Motor Starters, Thermal Overload Switches:	E	E	E	--
5. Combination Fire/Smoke Dampers, Smoke Dampers:	M	M	E	E
6. Section 230900 Automatic Temperature Controls: Valve and Damper Actuators, Low Voltage Electric Thermostats, Switches, other Miscellaneous Controls:	M	M	M	M
7. Electric Radiant Heating Panels, Baseboard Heaters, Cabinet Heaters, Unit Heaters:	M	M	E	M
8. Electric Duct Heating Coils:	M	M	E	M
9a. Duct Smoke Detectors:	E	M	E	E
9b. Relays and Ancillary Devices Associated with HVAC Unit Shutdown by Duct Smoke Detectors:	E	E	E	E
10. Electric Heat Trace:	M	M	E	M
11. Variable Frequency Drives:	M	M	E	M
12. Section 230900 Control Panels:	M	M	E	M

M = Division 22 and 23, Plumbing and HVAC

E = Division 26, Electrical

For purposes of the above table, responsibility of power and control wiring includes raceways, connections and other components as required for complete installation of wiring system.

\*\*\*END OF SECTION\*\*\*



**SECTION 26 05 19  
WIRE AND CABLES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes wire, cable, splices, and terminations for systems 600 Volts and less and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. NFPA 70, National Electrical Code (NEC).
  - 2. UL 83, Thermoplastic-Insulated Wires and Cables.
  - 3. UL 62275, Cable Ties for Electrical Installations
- C. Comply with NEC as applicable to construction and installation of electrical wire and cable. Electrical wire and cable UL listed and labeled.
- D. Comply with applicable portions of NEMA/Insulated Cable Districts Association standards pertaining to materials, construction and testing of wire and cable.
- E. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of wire and cable.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each type of wire, cable, and appurtenance.
- C. Test Reports:
  - 1. Field test reports.
  - 2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

PART 2 - PRODUCTS

2.01 POWER AND LIGHTING CIRCUITS

- A. Factory-fabricated conductors of sizes, ratings, materials and types indicated on the Drawings for each service. Where not indicated, select to comply with project's installation requirements and NEC standards. Comply with the following:
1. UL 83.
  2. Copper Conductor. No. 12 AWG and No. 10 AWG wire and cable to be solid. Wire and cable larger than No. 10 AWG stranded.
  3. Insulation type THWN-2, 600 Volt for circuits from 115 to 600 Volts.
  4. Use only 90 C insulated conductors based on 75 C ampacity tables of the NEC.
  5. Aluminum acceptable for feeder conductors rated greater than 100-amp.

2.02 CONTROL AND SIGNAL CIRCUITS

- A. Class 1:
1. UL 83.
  2. Stranded copper conductor.
  3. Insulation type THHN, or THWN, 600 Volt for circuits from 115 to 600 Volts.
- B. Class 2 and 3:
1. Copper conductor, 300 Volt insulation, rated 75 C in dry locations and 60 C in wet locations. Individual conductors twisted together and covered with non-metallic jacket unless otherwise noted on the Drawings.
  2. UL listed for use in air handling ducts and hollow spaces used as ducts and plenums.
  3. Category UTP cabling for electrical control systems:
    - a. Cable type per system manufacturer and shop drawings.
    - b. Cables shall meet the most current technical characteristics of TIA-568-C standard.
    - c. Cables shall be NFPA 262 CMP (plenum) rated, unless otherwise noted.
- C. Individual conductor insulation shall include separate color per code or applicable industry standard.

2.03 PLASTIC CABLE TIES

- A. Teflon or nylon, locking type

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 WIRING AND CABLE INSTALLATION, GENERAL**

- A. Install electric conductors and cables as indicated on the Contract Drawings, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation," and in accordance with recognized industry practices.
- B. Coordinate installation work with electrical raceway and equipment installation work for proper interface.
- C. Pull cables by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device made through approved swivel connection. Non-metallic jacketed cables of small size may be pulled directly by conductors by forming them into a loop to which pull wire can be attached. Remove insulation from conductors before forming loop. Larger sizes of cable may be pulled by using basket weave pulling grip, if pulling force does not exceed limits recommended by manufacturer. If pulling more than one cable, bind them together with friction tape before applying grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.
- D. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall pressure, and minimum allowable bending radius. In all cases, pulling tension applied to conductors limited to 0.008 lbs. per circular mil of conductor cross-section area.
- E. Pull in cable from end having the sharpest bend (bend closest to reel). Keep pulling tension to minimum by liberal use of lubricant, turning of reel, and slack feeding of cable into duct entrance. Employ not less than one person at reel and one in vault during this operation.
- F. For training of cables: provide 12 times cable diameter minimum bend radius to inner surface of cable.
- G. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50 percent greater than specified above for training.
- H. Apply wire and cable pulling compound recommended by specific cable manufacturer.
- I. Seal cable ends unless splicing is done immediately.
- J. Support cables in vaults, concrete trenches, and similar locations by cable racks. Secure to rack insulators with nylon cord or self-locking nylon cable ties. Place each cable on separate insulator.

- K. Follow manufacturer's instructions for splicing and cable terminations.
- L. Provide separate neutral conductor for each circuit serving single phase loads, unless indicated otherwise on the Contract Drawings. Where shared neutrals are indicated for multi-wire branch circuits, provide circuit breaker handle ties per Section 262813.
- M. Branch circuit wiring shall be grouped in separate raceways as indicated on the Contract Drawings. Where branch circuit raceways are not indicated on Contract Drawings, a maximum of three circuits may be installed in the same raceway if each circuit originates from the same panelboard.

### 3.05 WIRING METHODS, GENERAL

- A. Install wiring in raceways unless indicated otherwise on the Contract Drawings or authorized by the A/E.
- B. Install Wire After:
  - 1. Interior of building is protected from weather.
  - 2. Mechanical work likely to injure conductors is completed.
  - 3. Conduits have been cleaned and moisture removed.
- C. Neatly train and lace wiring inside boxes, equipment, and panel boards.
- D. Clean raceway system before installing conductors.
- E. Use half-lapped synthetic tape if taping is utilized for insulation purposes.
- F. Provide conductor support devices as required by NEC in vertical conduit runs.
- G. Torque conductor connections and terminations to manufacturer's recommended values.
- H. Maintain minimum 12-inch clearance between open cabling and heat sources such as flues, steam pipes, and heating appliances.

### 3.06 MINIMUM SIZES

- A. Minimum No. 12 AWG for power and lighting circuits.
- B. Minimum No. 14 AWG for control wiring.
- C. Power and lighting circuits with home run lengths greater than 100 feet. No. 10 AWG minimum.
- D. Power and lighting circuits with home run lengths greater than 150 feet. No. 8 AWG minimum.

### 3.07 CLASS 2 AND 3 CABLE INSTALLATION

- A. Class 2 and 3 Cable: Install using open cabling support methods at indoor locations where allowed by codes and where raceways are not required per Contract Drawings or for protection of cabling.

**3.08 OPEN CABLING INSTALLATION**

- A. Class 2 and 3 cabling: run exposed as "open cabling" above accessible ceilings, accessible ceiling plenums and where exposed in unfinished spaces, unless otherwise noted. Install class 2 and 3 cabling in raceway above hard ceilings, where exposed in finished spaces and where subject to damage.
- B. Provide all hanger supports and cable supports for cabling specified by Division 26, 27 and 28. All support structures shall adhere to the requirements in the National Electrical Code. Comply with requirements in Section 260529 Supporting Devices.
- C. Install cable bundles horizontal with a maximum deflection of two inches from the bottom of the cable support.
- D. Provide additional cable management products to protect exposed cabling and complete the installation of cabling in a neat professional manner.
- E. Maintain 12" clear from mechanical equipment and ductwork, fire protection piping and electrical raceways systems. Where limited space exists for cable routing, cables may cross ducts, piping and conduit systems perpendicular with minimum 4" separation. Maintain separation from all mechanical and electrical equipment, ductwork, piping, conduit, clearance spaces and structure.
- F. Maintain proper bend radius of cabling bundles and supports changing pathway direction as to not impact the physical jacket construction of the cabling. Replace cabling that becomes damaged during this transition in its entirety.
- G. Follow manufacturer's recommendations for quantity of cables supported in J-hooks and adjustable cable supports. Comply with requirements in Section 260529 Supporting Devices.
- H. Observe the applicable requirements and recommended good practices contained within TIA-568-C standard for cabling installation requirements.
- I. Protect exposed cables where subject to damage. Provide conduit sleeves with bushings at all wall, ceiling and floor penetrations.

**3.09 WIRING SPLICES AND TERMINATIONS**

- A. Splice only in accessible junction boxes.
- B. Splices and Taps:
  - 1. Use compression-set pressure connectors with insulating covers or screw-on pressure (wire nuts) for sizes No. 10 AWG and smaller.
  - 2. Use compression-set pressure connectors with insulating covers for wire splices and taps sizes No. 8 AWG and larger. Split bolt splices and connectors not acceptable.
  - 3. Push-in type conductor connectors (Wago, Ideal and similar) are not acceptable.
- C. Terminations: Eye-type compression lug when termination is to a bolt or screw terminal.
  - 1. 250 kcmil and larger, two-hole long barrel compression lugs.
  - 2. Smaller than 250 kcmil: Single hole compression lug.

- D. Tape un-insulated portions of conductor and connectors with electrical tape to 150 percent of conductor insulation value.
- E. Clean wires before installing lugs and connectors.
- F. Make splices, taps, and terminations to carry full capacity of conductors without perceptible temperature rise.
- G. Leave minimum 8 inches of pigtail at outlet boxes for connection to fixtures and devices. Where wiring is continued to other outlets, splice connection wire in a tap. In no case will continuity through double terminal of device be allowed for either hot or neutral leg of circuit.
- H. Insulate ends of spare conductors with electrical tape or wire nut.
- I. Terminate control circuit conductors at terminal blocks only.
- J. Utilize eye or forked tongue type compression set terminator for conductors No. 12 AWG and smaller when termination is to a bolted or screw set type terminal block or terminal cabinet.
- K. Make below grade splices in handholes and vaults watertight with epoxy resin type splicing kits similar to Scotchcast.

### 3.10 FIELD QUALITY CONTROL

- A. Test for Wires and Cables in accordance with Section 260810.
- B. Test Category 5e UTP cabling as follows:
  - 1. Horizontal cabling shall be certified to meet or exceed the permanent link performance specifications for Category 5e horizontal cabling tested with a frequency range from 1MHz to 100 MHz as defined in TIA-568-C.
  - 2. Certifications shall include the following parameters for each pair of each cable installed:
    - a. Building System
    - b. Cable identification between system devices
    - c. Date of test
    - d. Test equipment manufacturer and model number
    - e. Wire map
      - 1) Continuity to the remote end.
      - 2) Shorts between any two or more conductors
      - 3) Reversed pairs
      - 4) Split pairs
      - 5) Transposed pairs
      - 6) Any other miswiring
    - f. Length
    - g. Near-end crosstalk (NEXT)
    - h. Power sum-near-end crosstalk (PS-NEXT)
    - i. Return loss (RL)
    - j. Propagation delay (PD)
    - k. Delay skew (DS)

3. Horizontal cabling shall be tested using a Permanent Link configuration as defined in TIA-568-C.
  4. Test reports with an asterisk (\*) or fails, shall be documented identifying the reason for the test failure and a corrective action plan developed.
  5. After corrective action has been completed, the permanent link shall be retested.
  6. Ensure 100 percent of the horizontal cabling system links pass all tests.
- C. Test results shall be organized by building system type and cable identification number. The test results shall contain the date and time of when each test was saved in the memory of the tester. The test results shall be recorded in both PDF and manufacturer software formats and provided in the O&M manuals.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 05 21  
METAL CLAD CABLES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes metal clad (MC) cable for limited branch circuit systems 600 Volts and less and associated appurtenance.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASTM B 3, Standard Specification for Soft or Annealed Copper Wire.
  - 2. ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
  - 3. NFPA 70, National Electrical Code (NEC).
  - 4. UL 1569, Standard for Metal-Clad Cable.
  - 5. UL 1581, Reference Standard for Electrical Wires, Cables, and Flexible Cords.
  - 6. UL 83, Thermoplastic - Insulated Wires and Cables.
  - 7. UL 1479, Standard for Fire Tests of Through-Penetration Firestops.
  - 8. UL 44: Standard for Thermoset-Insulated Wires and Cables
  - 9. UL 1685: Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
  - 10. UL 2556, Standard for Safety Wire and Cable Test Methods
- C. Comply with NEC as applicable to construction and installation of MC Cable. Cable UL listed and labeled.
- D. Comply with applicable portions of NEMA/Insulated Cable Districts Association Standards pertaining to materials, construction and testing of wire and cable.
- E. Comply with applicable portions of ANSI/ASTM and IEEE Standards pertaining to construction of wire and cable.
- F. Comply with UL 1569 for Metal Clad Cable. Include UL label and manufacturer's "E" number.
- G. Provide only as allowed by the Owner and Jurisdiction.



1.04 **SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each type of MC Cable and appurtenance.
- C. Test Reports:
  - 1. Field test reports.
  - 2. UL test report for MC Cable.
  - 3. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

PART 2 - PRODUCTS

2.01 **METAL CLAD CABLES**

- A. Manufacturers:
  - 1. Southwire
  - 2. AFC Cable Systems, Inc.
  - 3. Encore
- B. Branch Circuits:
  - 1. Single Circuit and Multi-circuit with color-coded conductors. Comply with requirements in Section 260553.
  - 2. Conductors: Copper.
    - a. No. 10 AWG and smaller: Solid.
    - b. Larger than No. 10 AWG: Stranded.
  - 3. Conductor insulation: Heat, flame, moisture resistant dielectric layer manufactured and tested in compliance with UL 83.
    - a. Dry locations: THHN/THWN.
    - b. Damp and wet locations: THHN/THWN-2
  - 4. Electrical and Physical Properties of Copper Conductors: Conform to applicable standards referenced above. Soft-annealed copper in compliance with ASTM B 3 or ASTM B 8.
  - 5. Ground Conductor: Insulated grounding conductors sized in accordance with UL 1569, cabled with circuit conductors and identified in compliance with UL 1569.
  - 6. Circuit and grounding conductors cabled (twisted) with lay length and covered with polypropylene or polyester assembly tape.
  - 7. Armor: aluminum over cabled wire assembly with interlock in compliance with UL 1569.MC manufacture color system.
  - 8. Fittings: Malleable iron/steel, angled saddle type, electro zinc plated inside outside, equipped with nylon insulated throat fittings. Thomas and Betts series 3110 & 3150 series or approved. Direct bearing screw type fittings not acceptable. UL listed and labeled MC connectors manufactured for MC Cable Connectors.
  - 9. Anti-short bushings: Nylon.

**2.02 MC CABLE SUPPORTS**

- A. Cable Clamps, Straps, and Supports: Steel or malleable iron. Comply with requirements in Section 260529.

**PART 3 - EXECUTION**

**3.01 INSPECTION**

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section. Protect exposed cable from damage. Remove cable which proves to have faulty wiring and provide new. Abandoning existing and pulling new not acceptable. Repair, repull, and restrap MC Cable determined by the A/E to be poor installation.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 METAL CLAD CABLE INSTALLATION**

- A. Provide metal clad cables as indicated on the Drawings, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.
- B. Metal Clad cable may only be used for branch circuits for a maximum of 30 feet. All homeruns shall be conduit.
- C. Metal Clad cable shall be utilized only within concealed walls and above concealed ceiling spaces.
- D. Route parallel and perpendicular to building planes.
- E. Maintain minimum 6-inch clearance between cabling and piping. Maintain 12-inch clearance between cabling and heat sources such as flues, steam pipes, heating and hot water pipes, and heating appliances.
- F. Where cabling is run in parallel, group on common supports. Comply with requirements in Section 260529
- G. Coordinate installation work with equipment installation work for proper interface.
- H. Provide anti-short bushings at cut ends of armor.

- I. Install MC Cable After:
  - 1. Interior of building is protected from weather.
  - 2. Mechanical work likely to damage cables is completed.
- J. Minimum Sizes:
  - 1. No.12 AWG minimum for power and lighting circuits.
  - 2. No. 16 AWG minimum for 0-10V lighting control wiring.
- K. Splice only in accessible junction boxes.
- L. Verify continuity of each branch circuit conductor.
- M. Tape un-insulated portions of conductor and connectors with electrical tape to 150 percent of conductor insulation value.
- N. Include green wire ground. Jacket shall not serve as grounding means.
- O. Cut cable using equipment exclusively designed for such use with adjustable cutting depth or automatic means of armor separation. Seatek, Thomas & Betts, or approved.
- P. Insulate ends of spare conductors with electrical tape or wire nut.
- Q. Distance Between Supports: Maximum 6-foot centers and within 6 inches of each outlet, and junction box.
- R. Support cables below roof decking to provide minimum 1-1/2" separation from raceway surface to nearest surface of metal roof decking
- S. Route cable around structural members.
- T. Feeders: Acceptable where indicated in the Contract Drawings.
- U. Multi-Circuit Cables: a maximum of three circuits may be installed in a single multi-circuit cable if each circuit originates from the same panelboard. Provide a dedicated neutral for each branch circuit unless indicated otherwise on the Contract Drawings.

3.05 **FIELD QUALITY CONTROL**

- A. Comply with requirements in Section 260810. Include copy of field test report in the Operation and Maintenance Manual.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 05 26  
GROUNDING AND BONDING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes grounding and bonding systems, equipment, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. IEEE C2, National Electrical Safety Code (NESC).
  - 2. IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System Part 2: Normal Measurements.
  - 3. IEEE 837, Standard for Qualifying Permanent Connections Used in Substation Grounding
  - 4. NFPA 70, National Electrical Code (NEC).
  - 5. NFPA 780, Standard for the Installation of Lightning Protection Systems
  - 6. UL 467, Standard for Grounding and Bonding Equipment.
  - 7. UL486A-486B, Wire Connectors
  - 8. ANSI C119.4, Electric connectors - connectors to use between Aluminum-to-aluminum or aluminum-to-copper conductors
- C. Comply with NEC and IEEE requirements as applicable to electrical grounding and ground fault protection systems.
- D. Products UL listed and labeled.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each item and appurtenance.

- C. Shop Drawings: Plans showing dimensioned location of grounding system features, including ground rods, ground rings, test wells, grounding electrode system connections, and routing of grounding electrode conductors.
- D. Test Reports:
  - 1. Field test reports.
  - 2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 - PRODUCTS

### 2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

### 2.02 GROUNDING ELECTRODES AND CONDUCTORS

- A. Ground Rods: Copper clad steel, 3/4 inch diameter by 10 foot long. Copper-Weld Erico, Burndy, Harger, Thomas & Betts or approved.
- B. Bare Ground Conductors: Soft drawn copper. Stranded unless indicated otherwise. Tinned where indicated. Solid for No. 8AWG and smaller. Stranded conductors for No. 6 AWG and larger.
- C. Insulated Ground Conductors: Copper with 600 Volt insulation in accordance with Section 260519.
- D. Ground Bars: Predrilled rectangular bars of annealed copper, 1/4" inch by 4 inches with holes spaced 1-1/8 inches apart to accommodate lug connections. Length 18 inches unless indicated otherwise. Standoff insulators for wall-mounting.

### 2.03 GROUND CONNECTORS

- A. Listed and labeled for applications and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connections: Exothermic-welding kits of type recommended by kit manufacturer for materials being joined and installation conditions. Manufacturer: Cadweld, Thermoweld, Thomas & Betts, or approved.
- C. Compression Ground Connectors: Conform to IEEE 837 and UL 467.
  - 1. Cable-to-Cable Connections: Copper or copper alloy. Approved for direct burial or in concrete applications. Manufacturer: Thomas & Betts EZ-Ground® or approved.
  - 2. Cable-to-Busbar Connections: Two-hole long barrel compression lug, unless indicated otherwise on Contract Drawings.
  - 3. Cable-to-Cable Tray Connections: Two-hole long barrel compression lug.

- D. Mechanical Ground Connectors: Conform to IEEE 837 and UL 467.
  - 1. Cable-to-Water Piping Connections: Two-piece silicon bronze with stainless steel bolts. Listed for direct bury.
  - 2. Split-Bolt Connectors: Not acceptable.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.
- C. Preparation of Surfaces: Clean contacting surfaces of ground connections to bright metal before connecting.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. System ground not to exceed maximum 5 ohms meggered resistance.
- C. Ground each separately-derived system neutral to nearest building steel.
- D. Bond together system neutrals, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, underground metal water piping systems, and gas piping systems.

#### 3.04 GROUNDING ELECTRODE AND CONDUCTOR INSTALLATION

- A. Equipment Ground Conductor: Install separate, insulated equipment ground conductor in each feeder and branch circuit. Terminate each end on grounding lug, bus, and bushing and to intermediate metallic enclosures.
- B. Connect grounding conductors to motors in accordance with NEC. Remove paint, dirt, and other surface coverings at grounding conductor connection points so that good metal-to-metal contact is made.
- C. Bare Grounding Conductors Below Grade:
  - 1. Minimum 30 inches below grade.

2. Not in contact with gravel fill or concrete. Provide Schedule 40 PVC sleeve where routing through concrete.
  3. Train neatly around foundations and footings.
- D. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4/0 AWG. Bond to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- E. Size main grounding system per NEC. Provide conduit to protect ground wire from damage to an area 6 feet above floor.
- F. Conductor to Conductors, Conductor to Steel, and Conductor to Ground Rod: Exothermic-welded type connectors. Cadweld, Thermoweld, Thomas & Betts, or approved.
- G. When making bolted connection to aluminum and galvanized structures, apply corrosion-inhibitor to contact surfaces between cable, connector, and surface of structure. Penetrox A or approved.
- H. Ground Bars: Install where indicated on Contract Drawings. Install horizontally at 12 inches above finished floor, unless indicated otherwise.

### 3.05 GROUND CONNECTORS

- A. Welded Connections:
1. Provide for underground connections.
  2. Provide for connections to structural steel.
  3. Provide for connections to ground bars where indicated.
  4. Provide full weld between coupling and ground rod at joint.
  5. Connect grounding conductors to ground rods at upper end of rod with end of rod and connection point below finished grade, except provide bolted connections at test wells and as otherwise indicated.
  6. When making connections, wire brush or file point of contact to bare metal surface. Use welding cartridges and molds in accordance with manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and clean joint. Use connectors of specified size for conductors and ground rods. Notify A/E before backfilling ground connections.
- B. Ground shields of shielded power and control cable at each splice and termination as recommended by manufacturer.
- C. Ground metal sheathing and exposed vertical metal structural elements of building. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to equipment ground. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, instrument cabinets, raceways, and similar items carrying circuits to these devices.

### 3.06 FIELD QUALITY CONTROL

- A. Comply with requirements in Section 260810.

- B. Testing agency, approved by the Owner and the A/E, shall perform ground resistance testing of system. Perform test by means of fall-of-potential method. Maximum acceptable value 5 ohms.
1. Testing Instrument: Battery-powered or hand-cranked AC tester.
    - a. Indicates ground resistance in ohms from digital decade switches when unit's self-contained meter indicates null condition.
    - b. Range: 0.01 to 9990 ohms in 4 overlapping ranges.
    - c. Null condition occurs when no current flows through potential electrodes.
    - d. Instrument accuracy: Plus 2 percent or greater.
  2. Fall-of-Potential Test:
    - a. Connect instrument according to manufacturer's instruction.
    - b. Place rod P2 at various locations in line between tested electrode and probe C2 and plot results on graph (distance vs. resistance). Take sufficient readings to yield portion of plotted curve as being constant (rate of resistance change becomes so small with respect to distance as to be insignificant).
  3. Conduct 2 separate tests on opposite sides of grounding grid.
  4. Report failure to obtain specified ground resistance to the A/E.
- C. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- D. Include field test reports of grounding system in the Operation and Maintenance Manual.

\*\*\* END OF SECTION \*\*\*



**SECTION 26 05 27**  
**TELECOMMUNICATIONS GROUNDING SYSTEM**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes equipotential bonding and grounding system for telecommunications and low-voltage systems and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. CENELEC EN 50310, Application of Equipotential Bonding and Earthing in Buildings with Information Technology Equipment.
  - 2. IEEE C2, National Electrical Safety Code (NESC).
  - 3. IEEE 81, IEEE Guide For Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements.
  - 4. NFPA 70, National Electrical Code (NEC).
  - 5. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises.
  - 6. TIA-569-D, Commercial Building Standard for Telecommunications Pathways and Spaces.
  - 7. TIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Building.
  - 8. UL 467, Standard for Grounding and Bonding Equipment.
- C. Equipment regularly catalogued items of manufacturer and supplied as complete unit in accordance with manufacturer's standard specifications with optional items required for proper installation, unless otherwise noted on the Drawings.
- D. Comply with NEC, IEEE, TIA-607-C, and CENELEC EN 50310 requirements as applicable to grounding systems.
- E. Products UL listed and labeled.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.

- B. Product Data: Submit manufacturer's technical product data for each item and appurtenance.
- C. Test Reports:
  - 1. Field test reports.
  - 2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

1.05 **DEFINITIONS**

- A. Bonding: Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and capacity to conduct safely any current likely to be imposed.
- B. Bonding Conductor for Telecommunications: Conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
- C. Commercial Building: Building or portion thereof that is intended for office use.
- D. Earthing: International term equivalent to grounding.
- E. Effectively Grounded: Intentionally connected to earth through ground connection or connections of sufficient low impedance and having sufficient capacity to prevent buildup of currents that may result in undue hazard to connected equipment or to persons.
- F. Electrical Room: Facility for housing electrical equipment, panelboards, and controls. Room is recognized interface between electrical backbone riser and associated pathway.
- G. Entrance Facility (Telecommunications): Entrance to building for both public and private network service cables (including antennae) including entrance point at building wall and continuing to entrance room or space.
- H. Entrance Point (Telecommunications): Point of emergence of telecommunications conductors through exterior wall, concrete floor slab, or from rigid metal conduit or an intermediate metal conduit.
- I. Equipment Bonding Conductor (EBC): Conductor that connects equipment rack, server cabinet, PBX, and similar items to telecommunications grounding busbar to telecommunications main grounding busbar (TMGB), or telecommunications grounding busbar (TGB).
- J. Equipment Room (Telecommunications): Centralized space for telecommunications equipment that serves occupants of building.
- K. Exothermic Weld: Method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.
- L. Ground: Conducting connection, whether intentional or accidental, between electrical circuit or equipment and earth or some conducting body that serves in place of earth.
- M. Grounding Electrode System: Electrode(s) as specified in NEC.
- N. Grounding Equalizer: Conductor that interconnects elements of telecommunications grounding infrastructure.

- O. Pathway: Facility for placement of telecommunications cable.
- P. Primary Protector: Protector located at building telecommunications entrance point and listed under UL 497.
- Q. Protector: Device consisting of one or more protector units intended to limit abnormal surges on metallic communications circuits. Includes mounting assembly for protector units.
- R. Protector Unit: Device intended to protect against either overvoltage or overcurrent or both. Unit may contain carbon arresters, gas tubes, solid state devices, heat coils, PTC devices, or combination of these components for specific application.
- S. Telecommunications Room: Enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling as recognized location of horizontal cross-connect.
- T. Telecommunications Bonding Backbone (TBB): Copper conductor extending from TMGB to farthest floor TGB.
- U. Telecommunications Grounding Busbar (TGB): Busbar placed in convenient and accessible location and bonded by means of TBB to TMGB.
- V. Telecommunications Main Grounding Busbar (TMGB): Busbar placed in convenient and accessible location and bonded by means of bonding conductor to service equipment (power) ground.
- W. Termination Hardware: Device used to connect cables or wires for ease of cross connecting or for extension to another cable or equipment.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Pipe Clamps: Copper, UL listed and labeled grounding connector with pre-drilled lug pad allowing 2 hold compression terminal. Size of connector to accommodate pipe size. Burndy GAR-TC Series or approved.
- B. Communication Grounding Rods: Copper-clad steel, 1/2 inch by 15 foot long. Include ground connector. Burndy GAR Series, T&B GUV Series, or approved.
- C. Telecommunications Bonding Backbone (TBB): Conductors bare No. 3/0 AWG stranded insulated copper conductor, unless otherwise noted.
- D. Exothermic Welding: Appropriate fittings as required. Cadweld or Thermoweld.
- E. Telecommunications Main Grounding Busbar (TMGB):
  - 1. Copper plate, 1/4 inch thick by 4 inch wide by 20 inches long conforming to BICSI and TIA standards.
  - 2. Pre-drilled for bolts to secure bar to insulating standoffs. Mounting holes 3/8 inch diameter spaced 5.75 inches apart. Include insulators to isolate busbars from wall and other mounting surfaces.

3. Busbar pre-drilled with hole pattern to accommodate 2-hole lugs as follows: 27 lugs with 5/8 inch hole centers and 3 lugs, 1 inch hole centers.
  - a. Chatsworth Products, Inc., Part No. 40153-020
- F. Telecommunications Grounding Busbar (TGB):
  1. Copper plate, 1/4 inch thick by 2 inch wide by 10 inches long conforming to BICSI and TIA standards.
  2. Pre-drilled for bolts to secure bar to insulating standoffs. Mounting holes 3/8 inch diameter spaced 5.75 inches apart. Include insulators to isolate busbars from wall and other mounting surfaces.
  3. Pre-drilled with hole pattern to accommodate 2-hole lugs as follows: 4 lugs with 5/8 inch hole centers and 3 lugs, 1 inch hole centers.
    - a. Chatsworth Products, Inc., Part No. 13622-010
- G. Cable Terminals: Two-hole, non-insulated copper compression long barrel terminal, requiring 3/8 inch bolts on 1 inch and 5/8 inch centers. Burndy YA-2TC Series, T&B 256-30695 Series, or approved.
- H. Compression Taps: C-type to bond together 2 or more TBBs. Burndy YGHC Series or approved.
- I. Raised Floor Grounding: No. 6 AWG stranded bare copper grounding conductor bonded via exothermic weld to raised floor pedestals as indicated on the Drawings.
- J. Cable Tray Grounding:
  1. Terminal bolted to cable tray such that No. 6 AWG stranded copper cable can be laid into terminal without cutting and splicing cable. Grounding terminal manufactured for that purpose.
  2. Include ground straps at expansion joints and splice plates for electrical continuity.
- K. Equipment Rack/Server Cabinet: Grounding kit for each equipment rack or rack enclosure.
- L. Ferrous Conduit: Terminal bolted to conduit to allow laying No. 6 AWG stranded copper cable into terminal without cutting and splicing cable.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

### 3.04 GROUNDING INSTALLATION

- A. Install TMGB/TGB at locations as indicated on the Drawings. Insulate busbar from its support. Install minimum 2 inch separation from wall to allow access to rear of busbar.
- B. Connect bonding conductors for telecommunications from each equipment rack/server cabinet, cable tray, ferrous conduit, service equipment (power) ground, and similar items to TMGB and TGBs as indicated on the Drawings. Provide green insulated No. 6 AWG stranded copper conductor, unless otherwise noted.
- C. For PBX systems and equipment manufacturers, a separate TGB may be required for each manufacturer's equipment.
- D. Install bonding conductor for telecommunications from TMGB to electrical service grounding electrode in electrical room. Bonding conductor for telecommunications shall be same size as TBB as a minimum.
- E. Bonding conductors installed in ferrous metal conduit in general, not acceptable. If it is necessary to route bonding conductors through ferrous conduit for more than 3 feet, bond conductors to each end of conduit with No. 6 AWG conductor.
- F. Route bonding conductors as directly as possible. Avoid changes in elevation and sharp bends.
- G. Cable Terminals:
  - 1. Install manufacturers recommended compression die to compress terminal to cable at recommended compression pressure.
  - 2. Terminate grounding system cable by compression terminals except connections to grounding rods and raised floor and cable tray grounding terminals. Connections to these items shall be as specified elsewhere in this specification section.
- H. Exothermic Welding:
  - 1. Use exothermic welding where grounding connections are made underground, embedded in masonry or concrete, and installed in other inaccessible spaces.
  - 2. Follow manufacturer's installation instructions.

### 3.05 FIELD QUALITY CONTROL

- A. Comply with requirements in Section 260810.
- B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

- C. Test system at bonded points. Readings at any point maximum 5 ohms meggered resistance. Include field test results in the Operation and Maintenance Manual.

3.06 LABELING

- A. Comply with requirements in Section 260553.
- B. Label Telecommunications grounding components in accordance with TIA-607-C.
- C. Label Telecommunications Main Grounding Busbar "TMGB".
- D. Label TGBs with floor and an identifying number of a particular TGB. TGB of lowest numbered TR on the second floor would be labeled TGB201, the next TGB202, and so forth.
- E. Install labels on grounding and bonding conductors as close as practicable to their point of termination. Install in readable position. Labels nonmetallic.
- F. Label each Equipment Bonding Conductor (EBC) connected to a TMGB or TGB consecutively at each TMGB/TGB.
  - 1. EBC to TMGB starts at EBC101 consecutively to EBC199.
  - 2. EBC to TMGB201 starts at EBC201 consecutively to EBC299.
  - 3. EBC to TMGB301 starts at EBC301 consecutively to EBC399.
- G. Label each Telecommunications Bonding Backbone (TBB) conductor connected to TMGB consecutively. TBB to TMGB starts at TBB01.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 05 29**  
**SUPPORTING DEVICES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes conduit and equipment supports, fastening hardware, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data, rated capacities and accessories for each item and appurtenance.

**PART 2 - PRODUCTS**

**2.01 MATERIAL**

- A. General: Built-up framing for electrical raceway and equipment supporting systems, including but not limited to channel, rod, clamps, and hardware. Comply with requirements in Section 260548 for seismic restraints. Unless design is shown on the Drawings, size for 400 percent of calculated load.
- B. Channel: 12 gauge galvanized formed metal with or without pre-drilled holes, Pre-galvanized. Cooper B-Line, Unistrut, Powerstrut, or approved.
- C. Beam Clamps, in Pairs, at each Supporting (Structural) Beam: B-line B441-22 and B441-22A; Superstrut U-501 and U-502; Unistrut P2785, P2786, and P1379S, or approved. Submit other manufacturers for approval with evidence proving clamp complies with IBC and ASCE 7-05 for seismic requirements. Submitted proof can consist of letter signed and stamped by a professional Owner licensed in engineering in the state in which the Work is performed.

- D. Beam Clamps for Use with Rods: B-Line B751-J4, B751-J6, B751-J9, and B751-J12; Superstrut U-569; Unistrut P2824-6, P2824-9, and P2824-12, or approved. Submit other manufacturers for approval with evidence proving clamp complies with seismic requirements. Submitted proof can consist of letter signed and stamped by a professional Owner licensed in engineering in the state in which the Work is performed.
- E. Fittings for Attaching Channel-to-Channel for Built-Up Framing: Unistrut P6028, P6033, P6069, P6290, P6291, P6326, P6331, P6332, P6346, P6358A, P6359, P6381, P6382, P6726A, P6917, P6962, or approved.
- F. Connectors for Bracing: Unistrut P6186, P7097, P7098, P7100, P7101, P7108, P7109, P7110, P6546, or approved.
- G. Hardware, including Nuts (Locking Type), Bolts, and Set Screws: Corrosion resistant, designed for intended use.
- H. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
- I. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58
- J. Hanger Rods: Threaded steel
- K. Spring Steel Conduit Clips: Erico K series or approved.
- L. Circular Cable Retainer:
  - 1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
    - a. Manufacturer: Erico Caddy, Part No. CAT CR50
- M. J-Hooks:
  - 1. J-hooks shall have a galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
    - a. Manufacturer: Erico Caddy or approved:
      - 1) 1" Dia., Part No. CAT16HP
      - 2) 1-5/16" Dia., Part No. CAT21HP
      - 3) 2" Dia., Part No. CAT32HP
- N. Adjustable Cable Support:
  - 1. Adjustable cable supports shall be of steel and polyethylene, plenum rated, with unlocking and locking bar allowing additional cables to be added easily after installation.
    - a. Manufacturer: Erico Caddy, Part No. CAT425



- O. Outlet Box Support:
  - 1. Where more than one outlet box is shown on the Contract Drawings, and indicated to be at same elevation, align them exactly on center lines horizontally with wall mounting bracket.
    - a. Manufacturer: Cooper B-Line Series BB8 or approved:

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

#### 3.04 SUPPORTING DEVICES INSTALLATION

- A. Comply with requirements in Section 260548 for seismic restraints.
  - 1. Install diagonal bracing for trapeze support systems at 2 right angle planes to brace against:
    - a. Horizontal and torsional movement lateral seismic forces.
    - b. Vertical (uplift) movement caused by vertical seismic forces.
    - c. Horizontal distortions in conduit system caused by wire pulling.
- B. Unless otherwise shown on the Contract Drawings, attach connectors to vertical framing members with 2 bolts.
- C. Install toggle bolts or hollow wall fasteners in hollow masonry, plaster, and gypsum board partitions and walls. Install expansion anchors or preset inserts in solid masonry walls, self-drilling anchors, and expansion anchors on concrete surfaces. Comply with requirements in Section 260548 for seismic anchors.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated:
1. To Wood: Fasten with lag screws or through bolts.
  2. To New Concrete: Bolt to concrete inserts.
  3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    - a. To Existing Concrete: Expansion anchor fasteners.
    - b. To Steel: Beam clamps MSS SP-58, Type 19 or 23, complying with MSS SP-69.
    - c. To Light Steel: Sheet metal screws.
  4. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements
- E. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under nuts.
- F. Free Standing Electrical Equipment: Bolt to concrete base with leveling channels. Comply with requirements in Section 260510 for concrete base and Section 260548 for seismic restraints.
- G. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- H. Transformer Support: Comply with requirements in Section 262200.
- I. Lighting Fixture Supports: Fixture support wires for recessed ceilings, match ceiling support requirements. All fixture supports to comply with requirements in Section 265100 and Section 260548.
- J. Open Cabling Support Installation
1. Provide hanger supports and cable supports for cabling specified in Division 26. All support structures shall adhere to the requirements in the National Electrical Code.
  2. Space cabling supports no further than 4'-0" apart.
  3. Install cabling supports on their own dedicated support system.
- K. Raceways:
1. Single raceway runs: Spacing to comply with requirements of Section 260533
    - a. Suspended: support by threaded rod with spring steel conduit clips. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings
    - b. Mounted to building structure: single or double hole pipe straps.

2. Two or more parallel runs of raceway: Install trapeze support systems with 25 percent space (6 inches minimum) for future conduit runs. Refer to Section 260533 for spacing requirements.
3. Welding conduit and conduit fittings to structure not acceptable.
4. Spacing: Space so that fittings are accessible to accommodate pulling or splicing.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 05 33  
RACEWAY SYSTEMS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes conduit, electrical metallic tubing, wireway, surface metal raceway, and associated appurtenances within building perimeter.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.
- C. Refer to Section 260543 underground electrical work beyond building perimeter.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county and state codes and ordinances. Comply with local Utility requirements and standards.
- B. Codes and Standards:
  - 1. UL 1, Standard for Flexible Metal Conduit.
  - 2. UL 5, Standard for Surface Metal Raceways and Fittings.
  - 3. UL 6, Standard for Rigid Metal Conduit.
  - 4. UL 360, Standard for Liquid-Tight Flexible Metal Conduit.
  - 5. UL 514B, Standard for Conduit, Tubing, and Cable Fittings.
  - 6. UL 651, Standard for Schedule 40 and 80 Rigid PVC Conduit.
  - 7. UL 651A, Standard for Type EB and A Rigid PVC Conduit and HDPE Conduit.
  - 8. UL 797, Standard for Metallic Tubing – Steel.
  - 9. UL 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
  - 10. UL 1242, Standard for Intermediate Metal Conduit – Steel.
  - 11. UL 2420, Standard for RTRC Conduit and Fittings for underground – Fiberglass
  - 12. UL 2515, Standard for RTRC Conduit and Fittings for above ground - Fiberglass
- C. NEC Compliance: Comply with applicable portions of NEC as to type of products used and installation of electrical power connections.
- D. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NEC for workmanship and installation requirements of raceway systems.
- E. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes specified and whose products have been in satisfactory use in similar service for not less than 3 years.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each type of raceway system and appurtenance.

**PART 2 - PRODUCTS**

**2.01 RIGID METAL CONDUIT (RMC) AND FITTINGS**

- A. Ferrous Metal Conduit: Steel, UL 6, hot-dip galvanized.
- B. Fittings and Conduit Bodies: UL 514B, threaded galvanized.

**2.02 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS**

- A. Ferrous Metal Conduit: Steel, UL 1242, hot-dip galvanized.
- B. Fittings and Conduit Bodies: UL 514B, threaded galvanized.

**2.03 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS**

- A. Ferrous Metal Conduit: Steel, UL 797, hot-dip galvanized.
- B. Fittings: UL 514B, galvanized steel, insulated throat, rain tight compression ring type or set screw type. Drive-on type and cast fittings not acceptable.

**2.04 FLEXIBLE METAL CONDUIT AND FITTINGS**

- A. Ferrous Metal Conduit: Steel, UL 1, galvanized. UL listed for grounding as available. Aluminum and flexible metallic tubing not acceptable.
- B. Fittings: Insulated throat, UL 514B, galvanized steel, UL listed for grounding as available.

**2.05 LIQUID-TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS**

- A. Ferrous Metal Conduit: Galvanized with PVC weatherproof cover, UL 360 listed for grounding as available.
- B. Fittings: Insulated throat, UL 514B, galvanized steel, UL listed for grounding as available.

**2.06 RIGID NON-METALLIC CONDUIT**

- A. PVC Conduit: Schedule 40, UL 651, rigid type unless noted otherwise. UL 651A Type A permitted for underground concrete duct banks.
- B. Fittings: UL 651, UL 651A, UL 2420 and UL 2515.
  - 1. For electric (power) duct, 90 degree elbows with minimum 48 inch radius, factory manufactured rigid steel or Fiberglass (RTRC) with minimum 48 inch
  - 2. For telecommunications service provider ducts, 90 degree elbows with minimum 48 inch radius, factory manufactured rigid steel or Fiberglass (RTRC).

3. For telecommunications on-site distribution ducts, 90 degree elbows with minimum 36 inch radius factory manufactured rigid steel (RMC).

#### 2.07 SURFACE METAL RACEWAY

- A. UL 5, sheet metal channel with fitted cover. Type and size as shown on the Drawings.
- B. Finish: Enamel. Factory gray finish color.
- C. Fittings, Boxes, and Extension Rings: Designed for use with raceway systems.
- D. All raceway and fittings to be supplied by one manufacturer.
- E. Manufacturers: Wiremold.

#### 2.08 CONDUIT BODIES

- A. Conduit bodies cast malleable iron, zinc or cadmium plated with threaded connections. Covers gasketed, blank steel, or cast malleable iron, zinc or cadmium plated, and of same manufacturer as conduit body. Where conduit bodies are used as junction or splice boxes, comply with NEC.
- B. Conduit bodies (Smart LB) for telecommunications cables shall be die cast aluminum, gray powder coat paint finish, threaded connections with internal built-in radius. Covers gasketed, die cast aluminum, and of same manufacturer as conduit body. Madison Electric or approved equal.
  1. 1-1/4" Smart LB, Madison Electric, KLB120
  2. 2-1/2" Smart LB, Madison Electric, KLB 250
  3. 4" Smart LB, Madison Electric, KLB400

#### 2.09 WIREWAY AND AUXILIARY GUTTER

- A. UL 870, lay-in type, with hinged cover but without knockouts.
- B. Size: As shown on the Drawings, 4 by 4 inch minimum.
- C. Finish: Rust-inhibiting primer coat with manufacturer's standard enamel finish.

#### 2.10 EXPANSION FITTINGS

- A. Malleable iron, hot-dip galvanized allowing 4 inches (plus or minus 2 inches) conduit movement.
  1. RGC and IMC Raceway: OZ/Gedney Type AX series, Thomas and Betts Type EJJ series or approved.
  2. EMT Raceway: OZ/Gedney Type TX series, Thomas and Betts Type XJJ series or approved.

#### 2.11 SEALING FITTINGS

- A. Wall Sealing Fittings: At each wall sealing fitting, include conduit seal fitting, OZ/Gedney FSK Series or approved.

- B. Raceway Stubups and Stubouts: Conduit seals together with wall sealing fittings. OZ/Gedney CSB Series or approved.
- C. For Exterior Wall Penetrations below Grade: Include sealing bushing at interior end of penetrating raceway. Only threaded fittings are permitted in entering raceways ahead of sealing bushing. OZ/Gedney Type CSB or approved.
- D. Hazardous location/explosion resistant fittings: At hazardous location boundaries as identified on plans, include conduit seal fitting Crouse Hinds EYS series or approved.

#### 2.12 CONDUIT SUPPORTS

- A. Conduit Clamps, Straps, and Supports: Steel or malleable iron. Comply with requirements in Section 260529.

#### 2.13 FIRE RATED SEALING COMPOUND

- A. Dow Corning 3-548 Silicone RTV Foam or approved.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

#### 3.04 RACEWAY SIZING, ARRANGEMENT, AND SUPPORT

- A. Unless otherwise shown on the Drawings, size conduit for conductor type installed. Minimum size 3/4 inch.
- B. Install conduit to maintain headroom and present neat appearance in unfinished spaces. Install a minimum of 9'-6" above finished floor in spaces unless otherwise indicated on the Contract Drawings.

- C. Install conduit concealed in walls, below floors, and above ceiling in spaces, except conduit may be exposed in mechanical rooms, electrical rooms, and similar unfinished spaces. Horizontal conduit installation is not allowed in floor slab unless specifically noted on electrical and structural drawings.
- D. Route conduit parallel and perpendicular to building planes.
- E. Maintain minimum 6 inch clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, heating and hot water pipes, and heating appliances.
- F. Brace conduit or conduit supports to prevent distortion of alignment by wire-pulling operations.
- G. Where conduit is run in parallel, group on formed channel supports. Comply with requirements in Section 260529.
- H. Do not fasten or support with wire or perforated pipe straps. Remove temporary conduit supports used during construction before conductors are pulled.
- I. Raceway to be routed around structural members. Structural Engineer to approve proposed modifications of structural elements prior to commencement of work.

### 3.05 RACEWAY INSTALLATION

- A. Cut conduit square using a saw or pipe cutter. Deburr cut ends.
- B. Bring conduit to shoulder of fittings and couplings and tighten securely.
- C. Use conduit hubs for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.
- D. Do not use conduit bodies to make sharp changes in direction unless shown on the Drawings.
- E. Use hydraulic one-shot conduit bender or factory elbows for bends in 2 inch conduit and larger.
- F. Provide plastic bushings on conduit stubs used for transition from conduit to open cable runs.
- G. During construction, use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.
- H. Distance Between Supports:
  - 1. Threaded Rigid Metal Raceways: Maximum ten foot centers and within 18 inches of each outlet, junction box, and bend.
  - 2. Electrical Metallic Tubing: Maximum ten foot centers at each bend and within 12 inches of each outlet, junction box, and coupling.
  - 3. Surface Metal Raceway, Auxiliary Gutter, and Wireway: Maximum 5 foot centers or in accordance with manufacturer's instruction, whichever is less, unless otherwise shown on the Drawings.



- I. Provide polyester mule tape with printed footage indicators secured at each end of each empty conduit, except sleeves and nipples. Identify with tags at each end indicating origin and destination of empty conduit. Minimum tensile strength of 1250 pounds for conduits 2-inch and smaller and 2500 pounds for conduits larger than 2-inch.
- J. Route conduit through roof inside openings for ductwork where possible. Otherwise, install through roof jack and seal weather tight.
- K. Install no more than equivalent or four 90 degree bends between boxes.
- L. Avoid moisture traps where possible. Where unavoidable, install junction box with drain fitting at conduit low point.
- M. Raceway Installation below Slab on Grade:
  - 1. Installed a minimum of 2 inches below bottom of slab.
  - 2. Arrange and slope raceway to drain away from building.
  - 3. Install insulated grounding bushings at conduits stubbed up or out from underground unless capped for future (spare).
  - 4. Wipe PVC conduit clean and dry before jointing. Apply full even coat of cement to entire area to be inserted into fitting. Let joint cure for minimum 20 minutes.
  - 5. Install conduit that stub up through floor at such depth that exposed conduit is vertical and no curved section of elbow is visible.
- N. Sealing of Conduit Penetrations:
  - 1. Exterior Wall Surfaces Above Grade: Seal around penetrations with caulking approved by the A/E. For concrete construction above ground level, cast conduit in wall or core drill wall and hard pack with mixture of equal parts of sand and cement.
  - 2. Exterior Wall Surfaces Below Grade: Cast conduit into wall (and floor) or use manufactured seal assembly cast in place.
  - 3. Roofs: Install mopped and flashing roof jack and where conduit penetrates roof membrane.
  - 4. Fire Rated Construction: Seal penetrations with fire rated sealing compound to maintain fire rating of construction penetrated.
- O. Sealing of Raceways: Seal interior of raceways that pass through building roof and through outside walls of building, above or below grade. Seal on end inside building. Use raceway sealing fittings manufactured for purpose sealed with non-hardening, compound-type mastic, specially designed for such service. Pack around wires in raceways.
- P. Raceways on exterior surface of building: Install only when shown on the Drawings and as approved by the A/E.
- Q. Where flexible metal or liquid tight flexible metal conduit is installed, install bonding conductor to insure electrical continuity of raceway. Route bonding jumper inside conduit and terminate at grounding bushing or grounding locknut installed on inside of junction boxes at each side of flexible section. In instances where this method is not feasible (such as when cast boxes with hubs are used or where required by the NEC, route bonding jumper on outside of flexible conduit and terminate in accordance with methods acceptable to the AHJ.
- R. Raceway shall not penetrate sheet metal ducts.

- S. Branch circuits: install overhead, except circuits serving floor boxes, outdoor circuits or unless indicated otherwise on the Contract Documents.
- T. Support raceways below roof decking: provide minimum 1-1/2" separation from raceway surface to nearest surface of metal roof decking.
- U. Spare Raceways: Install 6 spare 3/4 inch conduits (capped) from each recessed/flush mounted branch panelboard into ceiling space or mechanical platform if one exists. Extend conduits required distance necessary to reach accessible ceiling space.
- V. In finished areas with exposed structure, subject to the approval of the A/E, raceways may be installed exposed. Install raceways as high as possible, provide minimum 1-1/2" separation from raceway surface to nearest surface of metal roof decking, and neatly arranged. Submit shop drawing indicating routing of proposed surface raceways and boxes in finished areas.
- W. Service Entrance Feeders: Where raceway for service entrance, install conduit under ground level slab or in 2 inch thick concrete encasement. Coordinate concrete encasement installation with A/E prior to installation to avoid conflicts with other disciplines. Comply with NEC requirements.

### 3.06 SURFACE METAL RACEWAY INSTALLATION

- A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.
- B. Install insulating bushings and inserts at connections to outlets and corner fittings.
- C. Maintain grounding continuity between raceway components for continuous grounding path.
- D. Fastener Option: Use manufacturer's standard clips and straps for installed purpose.

### 3.07 AUXILIARY GUTTER INSTALLATION

- A. Bolt auxiliary gutter to steel channels fastened to wall or in self-supporting structure. Install level.
- B. Gasket each joint in oil-tight gutter.
- C. Mount rain tight gutter in horizontal position only.

### 3.08 RACEWAY SCHEDULE

- A. Rigid Metal Conduit:
  - 1. Acceptable in all locations except as modified in this section.
  - 2. Where in contact with earth or concrete, install protective coating consisting of spirally wrapped 20 mil PVC tape with 1/2 inch minimum overlap - 3M Scotchrap Tape 51 or approved - or utilize PVC Coated Rigid Metal Conduit. Completely wrap and tape field joints.
  - 3. Required for exposed raceways in areas subject to physical damage including but not limited to the following areas:
    - a. Loading Docks

- B. PVC Coated Rigid Metal Conduit:
1. Required in corrosive environments or where indicated on the Contract Drawings.
- C. Intermediate Metal Conduit:
1. May be used in lieu of rigid metal conduit unless otherwise prohibited by code or indicated on the Contract Drawings.
  2. Not acceptable for circuits over 600 Volts.
- D. Electrical Metallic Tubing:
1. Acceptable for dry interior locations where not exposed to moisture or physical damage.
  2. Not acceptable for circuits over 600 Volts.
- E. Rigid Non-Metallic Conduit:
1. Acceptable below concrete slab on grade installed a minimum of 2 inches below bottom of slab.
  2. Not acceptable for exposed raceways extending through floor slab; utilize Rigid Metal Conduit.
  3. Not acceptable for bends 45 degrees and greater unless concrete encased; utilize Rigid Metal Conduit as specified herein, PVC Coated Rigid Metal Conduit or Fiberglass (RTRC). Field bends not acceptable.
  4. Concrete encased where indicated on Contract Drawings or where required by Code or Utility.
- F. Flexible Steel Conduit:
1. For connections to recessed light fixtures and devices installed in suspended ceilings, maximum six foot length.
  2. For connections to motors, transformers and other equipment subject to vibration. Minimum of three foot and maximum of six foot length with 90 degree loop.
- G. Liquid-Tight Flexible Metal Conduit.
1. For pump motors and equipment subject to vibration in damp and wet locations, in areas subject to being washed down, and for machinery where cutting oil is used. Minimum of three foot and maximum of six foot length with 90 degree loop.
- H. Surface Metal and Multi-Outlet Raceway: Install where indicated on the Contract Drawings.
- I. Auxiliary Gutters and Wireways: Install where indicated on the Contract Drawings and as required in unfinished spaces. Elsewhere as approved by the A/E.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 05 34  
OUTLET BOXES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes outlet, junction, and pull boxes and associated appurtenances required to enclose devices, permit pulling conductors, and for wire splices and branches.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 2. NFPA 70, National Electrical Code (NEC).
  - 3. UL 514A, Metallic Outlet Boxes.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each type of outlet box and appurtenance.

**PART 2 - PRODUCTS**

**2.01 OUTLET BOXES FOR INTERIOR WIRING**

- A. General: Outlet and pull boxes pressed steel, zinc coated with plaster ring where applicable, minimum 4 inch size.
- B. Telecommunications and Audio Visual: Outlet and pull boxes galvanized steel, with plaster ring where applicable, minimum 4-11/16 inch, 3-1/4-inches deep.
- C. Surface Metal Raceway: Boxes of same manufacturer and to match raceway. Boxes shall accommodate standard devices and device plates.

- D. Concrete and Masonry: Boxes for casting in concrete and mounting in masonry walls of type specifically designed for that purpose.
- E. Ceiling Outlet Boxes: Galvanized octagonal 4 inch, 1-1/2 inches deep (without fixture stud) and 2-1/8 inch deep (with fixture stud).
- F. Sheet Metal Boxes Larger than 12 Inches in any Dimension: Include hinged enclosure.

**2.02 OUTLET BOXES FOR EXTERIOR WIRING**

- A. General: Weather resistant and rain tight, with appropriate covers, gaskets, and screws.
- B. Above Grade: Outlet and junction boxes cast or malleable iron or cast of corrosion resistant alloy compatible with raceway to which they are connected. Pull boxes fabricated of hot dipped galvanized heavy gage steel. Boxes with gasketed covers.
- C. Below Grade: Provide underground vaults as specified in Section 260543.

**2.03 OUTLET BOXES CONTAINING MULTIPLE DEVICES**

- A. Outlet Boxes Containing Emergency and Normal Devices: Permitted only with steel barriers manufactured especially for purpose of dividing outlet box into 2 completely separate compartments.
- B. Outlet Boxes Containing Multiple Devices and Wiring Rated over 150 Volts to Ground and Over 300 Volts Between Conductors: Permitted only with steel barrier manufactured especially for purpose of dividing outlet box into separate compartments for each device having exposed live parts.

**PART 3 - EXECUTION**

**3.01 INSPECTION**

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 COORDINATION OF OUTLET BOX LOCATIONS**

- A. Locate as shown on the Drawings and as required to facilitate pulling. Limit number of bends per NEC.
- B. Electrical box locations shown on the Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets before roughing in.
- C. Locate outlet boxes to allow access. If inaccessible, furnish, arrange, and pay for installation of access doors.
- D. Coordinate Work of this section with the Work of other sections and trades to avoid conflicts. Check and verify door swings and locations of built-in cabinets, plumbing, heating, and ventilating equipment.
- E. Install outlet boxes of sizes and at locations necessary to serve equipment furnished under this or other divisions of the specifications. Make final connections thereto. Outlet boxes required if equipment is furnished with pigtail for external connection, does not have space to accommodate branch circuit wiring, or requires wire with insulation rating different from branch circuit wiring. Review equipment Shop Drawings for required outlet locations.
- F. Where more than one outlet box is shown on the Drawings, and indicated to be at same elevation or one above the other, align them exactly on center lines horizontally or vertically. Relocate outlet boxes which are not so installed (including lighting, receptacle, power, signal, and temperature control outlets) at no additional cost to the Owner.
- G. Centered on Built-In Work: In the case of doors, cabinets, recessed or similar features, or where outlet boxes are centered between such features, such as between door jamb and cabinet, make these outlet box locations exact. Relocate outlet boxes which are not centered.
- H. Flush mount boxes with front edge of box or plaster ring even with finished surface of wall and ceiling, except those mounted above accessible ceilings and where surface mounting is permitted.
- I. Locate to maintain headroom and to present a neat appearance.
- J. Route conduit from switch and receptacle boxes in walls vertically to space above ceiling. Install junction box before horizontal run.
- K. Offset outlet boxes minimum of one stud horizontal separation between flush boxes mounted on opposite sides of acoustic rated common wall.
- L. Install outlet boxes with minimum 6 inch horizontal separation between closest edges of flush boxes mounted on opposite sides of common wall.
- M. Ceiling Locations: Locate outlet either at corner joint or in center of a panel, whichever is closer to normal spacing. Locate outlet boxes in same room in same panel locations.
- N. Conceal outlet boxes for electric water coolers behind cooler unit housing.

**3.05 OUTLET BOX INSTALLATION**

- A. Anchor boxes so they will not shift or rock when devices are operated (including insertion and removal of cord caps).

- B. Firmly anchor flush outlet boxes directly or with concealed bracing to studs and joists.
- C. Close unused openings.
- D. Support boxes independently of conduit except for cast outlet boxes that are connected to 2 rigid metal conduits, both supported within 12 inches of outlet box.
- E. Use multiple-gang outlet boxes where 2 or more devices are mounted together. Do not use sectional boxes.
- F. Install blank covers or plates over outlet boxes that do not contain devices.
- G. In inaccessible ceiling areas, install outlet and junction boxes within 6 inches of recessed luminaire to be accessible through luminaire ceiling openings.
- H. Install recessed outlet boxes in finished areas. Secure outlet boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall and adjustable steel channel fasteners for flush ceiling outlet boxes.
- I. Install outlet boxes in walls without damaging wall insulation.
- J. Seal conduit boxes, telephone boxes, and similar items airtight with acoustical caulk where located in acoustical rated walls that are not fire rated.
- K. Install outlet boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for outlet boxes. Use outlet boxes with sufficient depth to permit conduit hubs to be located in masonry void space.
- L. Install pull boxes to be accessible after completion of building construction.

**3.06 ELECTRICAL WORK IN COUNTERBACKS, MILLWORK, AND CASEWORK**

- A. Install as shown on the Drawings. Furnish templates to other trades for drilling and cutting to ensure accurate location of electrical fixtures (outlets and devices) as verified with the A/E. Install wiring, devices, plates, and connections required by said fixtures.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 05 35  
FLOOR OUTLET DEVICES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes floor outlet devices for power and communications and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. NFPA 70, National Electrical Code (NEC).
  - 2. UL 514A, Metallic Outlet Boxes.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each type of outlet device and appurtenance.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Flush Type Outlet Devices: Hubbell, Wiremold, Steel City, or approved.

**2.02 INDIVIDUAL SERVICE FLUSH FLOOR OUTLET DEVICES**

- A. Fully Adjustable, Cast Iron:
  - 1. Box, 4-3/8 inches square by 3-3/16 inches deep. Hubbell B24 series.
  - 2. Duplex Convenience Outlet Cover: Aluminum, duplex flap. Hubbell SA-3825.
  - 3. Telephone and Communication Outlet Cover: Aluminum, combination screw plugs. Hubbell SA-2425.
  - 4. Special Purpose Outlet: Aluminum, screw cover, to suit device configuration.



5. Carpet Flanges: Aluminum.

### 2.03 MULTI-SERVICE RECESSED FLOOR OUTLET DEVICES

#### A. Slab on Grade and Concrete Deck Floor Boxes.

1. Manufacturer: FSR
2. Floorbox Capacity:
  - a. Provide 4 gang and 8 gang boxes as indicated on drawings.
  - b. Model. 4 gang – Model FL-400-SSQ-C; 8 gang – Model FL-500P-4-SSQ-C
  - c. Provide gang plate dividers and center dividers to separate power and low voltage compartments
  - d. Overall dimensions
    - 1) 4 Gang: 14 1/8 inches long by 10 1/8 inches wide by 5 inches deep.
    - 2) 8 Gang: 12 1/8 inches long by 10 inches wide by 4 inches deep.
  - e. Size and quantity of threaded conduit openings.
    - 1) 4 Gang
      - a) Eight 3/4"
      - b) Two 2", Four 1 1/2"
    - 2) 8 Gang
      - a) Eight 3/4"
      - b) Four 1" or 1-1/4"
      - c) Eight 3/4", 1" or 1-1/4"
3. Cover shall be gray finish. Provide gray solid cover at all areas.
  - a. At areas with finished concrete flooring provide: Model FL-500P-SLD-GRC-C
  - b. At areas with carpet provide: Model FL-SLP-GRY-C
4. Provide pour pan accessory at slab on grade locations.
- 5.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 FLOOR OUTLET DEVICE INSTALLATION**

- A. Install and anchor floor outlet devices shown on the Drawings. Coordinate exact location with the A/E.
- B. Attach conduits to cast iron housing.
- C. Align coverplate over top of housing and tighten screws.
- D. Level box and pour concrete.
- E. Adjust top surface to level and flush with finished floor.

**3.05 CARPET FLANGE INSTALLATION**

- A. Install after final floor covering has been installed.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 05 36  
CABLE TRAYS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete cable tray systems as shown on the drawings.
- B. Cable tray systems are defined to include, but are not limited to, straight sections of cable trays, bends, tees, elbows, drop-outs, covers, supports and accessories.
- C. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work of this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county and state codes and ordinances.
- B. Codes and Standards:
  - 1. NFPA 70, National Electrical Code (NEC).
  - 2. National Electrical Manufacturers Association:
    - a. NEMA VE1 Metallic Cable Tray Systems.
    - b. NEMA VE2 Cable Tray Installation Guidelines.
  - 3. ASTM International:
    - a. ASTM A123/A123M - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    - b. ASTM A510 - General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
    - c. ASTM B633 - Electrodeposited Coatings of Zinc on Iron and Steel.
    - d. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - 4. International Electrotechnical Commission:
    - a. IEC 61537 - Cable Management - Cable Tray Systems and Cable Ladder Systems.

5. TIA-569-D: Commercial Building Standard for Telecommunications Pathways and Spaces.

#### 1.04 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for each type of cable tray and appurtenance.
- C. Shop Drawings: Indicate (using large scale) details of construction conditions, joints and accessories, dimensions, and finishes.

### PART 2 - PRODUCTS

#### 2.01 TYPE OF CABLE TRAY

- A. Cable tray shall be continuous, rigid, welded steel wire mesh cable management system to permit continuous ventilation of cables and maximum dissipation of heat.
- B. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 12 inches on center. Spacing in radiused fittings shall be 12 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails.
- C. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) mechanically fastened to the side rails. Rungs shall be spaced 9 inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width.

#### 2.02 MATERIALS AND FINISH

- A. Wire mesh type shall be continuous rigid, carbon steel, welded at intersections. Material shall contain an electrozinc finish.
- B. Aluminum Ladder Tray: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.

#### 2.03 CONSTRUCTION

- A. Wire mesh cable tray shall be manufactured with Safe-T-Edge design with the lateral wires welded to the bottom edge of the top wires eliminating any sharp edges.
- B. Ladder tray straight sections, fitting side rails and rungs and fabricated parts shall be manufactured with aluminum.

#### 2.04 DIMENSIONS

- A. Wire mesh type cable tray shall be 2 inches in overall height. Width as shown on the Drawings.

- B. Aluminum ladder tray shall consist of two longitudinal members that are 4 inches deep (side rails) with transverse members (rungs) welded to the side rails.
- C. The ladder tray width shall be as indicated on drawings and rungs shall be spaced 12 inches on center.
- D. Straight cable tray sections shall be supplied in standard 10'-0" sections, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.

**2.05 MANUFACTURERS**

- A. Wire Mesh Cable Trays: Cablofil or approved equal.
- B. Aluminum Ladder Trays: B-line, Redi-Rail or approved equal.

**2.06 SPLICE PLATES**

- A. Cable tray sections shall be mechanically and electronically continuous at all splices, changes in elevation, etc. Connections between sections shall attach using hardware and accessories of the same manufacturer as the cable tray and shall be installed per manufacturer's recommendations.
- B. Connections shall be listed by a Nationally Recognized Testing Laboratory as electrically continuous for purpose of grounding continuity, or supplemental bonding jumpers shall be provided at connections.
- C. Splicing assembly shall be UL rated as a bonding interconnect between cable tray sections.
- D. Aluminum Ladder Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1.

**2.07 BEND RADIUS SWEEPS**

- A. Provide sweeping bends in cable tray pathway as shown on the contract drawings. Field modify cable tray as required. Edges shall be sanded to a smooth finish and shall be free of sharp edges. Bend radius sweeps shall meet the requirements of TIA-569-D standard.
- B. Bend radius support assemblies shall lock the cable tray sweep between cut sections of the side wall of the cable tray.
- C. Bend radius support assemblies shall utilize the FAS system.
  - 1. Cablofil Part No. FASLOCK XL.
- D. Spacing in radiused fittings shall be 12 inches and measured at the center of the cable tray width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails.

**2.08 CEILING SUPPORTS**

- A. Provide manufacturer's recommended support mechanism or Unistrut support of cable tray for installation above the ceiling space. Unistrut width shall be a maximum of 2 inches greater than the longest width of cable tray.

- B. Threaded rod shall be supported on each side of the support mechanism. Center hung supports shall be prohibited.
- C. Provide all components for securing threaded rod to the ceiling structure, support and cable tray.
- D. Cable tray supports shall be placed so that the support spans shall not exceed 5'-0" on center.
- E. Unistrut supports shall utilize the FAS system.
- F. Supports shall be installed utilizing hanger rod brackets for 3/8" ATR or 1/2" ATR or using 1/4" ATR through Redi-Rail holes on the top flange.

**2.09 WALL MOUNT SUPPORT**

- A. Provide manufacturer's wall mounted brackets or Unistrut supports for cable tray installation on vertical and horizontal pathways mounted to the wall structure. Unistrut width shall be a maximum of 2 inches greater than the longest width of cable tray.
- B. Provide necessary bolt and anchoring devices to attach cable tray and supports to the wall structure.

**2.10 LOADING CAPACITIES**

- A. Ladder tray & solid bottom cable tray shall be capable of carrying uniformly distributed cable load of 200 pounds per foot when supported on 10 foot span when supported as a simple span and tested per NEMA VE1 Section 5.2.
- B. Wire mesh cable trays shall be capable of carrying uniformly distributed cable load of 88.7 pounds per foot when supported on 8' foot span when supported as a simple span and tested per NEMA VE1 Section 5.2.

**2.11 FITTINGS**

- A. Provide pre-manufactured T-intersections and 90-degree horizontal and vertical directional fittings for cable tray pathways. Field modification of straight sections to provide directional changes shall be prohibited.
- B. Fittings shall have a minimum radius of 24 inches to accommodate cables installed in trays.

**2.12 ACCESSORIES**

- A. Include related accessory items such as dropouts, end plates, barrier strips to separate services in trays support and seismic bracing components, grounding lugs, and installation rollers. Covers furnished for cable protection for vertical riser trays as they penetrate floors and similar applications.
- B. Seismic Bracing Kit:
  - 1. Provide seismic bracing of cable tray. Seismic bracing shall meet the requirements of the AHJ.

- C. Cable Entry/Exit Supports:
  - 1. For horizontal and backbone cabling entering and exiting the cable tray from the side or bottom, provide a bend radius support assembly to protect the cables from sharp bends.
  - 2. For horizontal and backbone cabling entering and exiting at the end of a cable tray pathway, provide a bend radius support assembly to protect the cables from sharp bends.
- D. Provide all grounding and bonding of cable tray pathway to the nearest telecommunications grounding busbar.
- E. Provide all miscellaneous hardware and components for a complete and operational pathway system.

### PART 3 - EXECUTION

#### 3.01 GENERAL

- A. Install, apply, erect, and perform the work in accordance with Article 1.2 Quality Assurance provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Installation of cable trays shall be in accordance with applicable portions of TIA-569-D, Commercial Building Standards for Telecommunications Pathways and Spaces.
- C. Cable tray shall be braced or anchored to resist a lateral force facing in any direction in accordance with the IBC, NEC and all local amendments to these codes and/or any other applicable requirements of the AHJ.
- D. Contractor shall coordinate with the project structural engineer and the AHJ to determine the extent seismic bracing is required. Provide seismic bracing as required by the structural engineer and by the AHJ.
- E. At the completion of installation, the cable tray system shall be level and plumb, and shall present a neat appearance. Cable tray interiors shall have no sharp edges or protrusions (to prevent abrasions of cabling or injury to personnel).
- F. Install fire protection at all wall and floor penetrations. Install firestop material within installed cable trays after cabling has been installed through slot or sleeve penetrations.

#### 3.02 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.03 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

### 3.04 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. Install cable tray system at locations indicated on the drawings. Installation shall be in accordance with manufacturer's instructions and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.
- B. Support the cable tray on 5' centers for a total of 2 supports for every 10' span when the cable tray is supported from the ceiling. Support cable tray at every transition. Support cable tray utilizing wall mount brackets or Unistrut hangers.
- C. Provide additional brackets on ends, and two additional brackets at tees and corners. Securely fasten cable tray to brackets and supports using clamps manufactured for the purpose. Provide all required inserts, hardware and supports.
- D. Coordinate cable tray with electrical, mechanical and structural systems as necessary to properly integrate installation of cable tray.
- E. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.
- F. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE2 guidelines, or in accordance with manufacturer's instructions.
- G. Cutting:
  - 1. Provide mechanical or power operated bolt cutters for providing changes in direction and height transitions with the cable tray. Adhere to manufacturer's recommendations for devices and tools to provide the installation of the cable tray.
  - 2. Cut wires in accordance with manufacturer's instructions.
  - 3. Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.
  - 4. Cut each wire with one clean cut to eliminate grinding or touch-up.
- H. Install cable tray system using hardware, splice connectors, support components, and accessories furnished by manufacturer.
- I. Cable tray shall be grounded in accordance with manufacturer's specifications and shall comply with requirements in Sections 260526 Grounding and 260527 Telecommunications Grounding System.

### 3.05 TESTING

- A. Test cable trays to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.

\*\*\*END OF SECTION\*\*\*



**SECTION 26 05 43  
UNDERGROUND VAULTS AND RACEWAYS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Underground electrical work beyond building perimeter including vaults, handholes, direct-buried conduit, ductbanks, and associated appurtenances.
- B. Provide, coordinate and obtain approval for underground electrical work for utility systems in accordance with utility company requirements.
- C. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.
- D. Refer to Section 260533 for work within building perimeter.
- E. Refer to Section 260510 for additional earthwork requirements.

**1.02 RELATED REQUIREMENTS**

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

**1.03 DEFINITIONS**

- A. Vault: Underground structure for electrical equipment and wiring.

**1.04 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances. Comply with local Utility requirements and standards.
- B. Codes and Standards:
  - 1. UL 6, Standard for Rigid Metal Conduit.
  - 2. UL 651, Standard for Schedule 40 and 80 Rigid PVC Conduit.
  - 3. UL 651A, Standard for Type EB and A Rigid PVC Conduit and HDPE Conduit.
  - 4. UL 2420, Standard for RTRC Conduit and Fittings for underground – Fiberglass.
  - 5. AASHTO M-306, Standard for Drainage, Sewer, Utility and Related Castings.
  - 6. Electric Utility Requirements.
- C. NEC Compliance: Comply with applicable portions of NEC as to type of products used and installation of electrical power connections.
- D. Comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein. Comply with NEC for workmanship and installation requirements of underground vaults, conduit and ducts.

- E. Manufacturers: Firms regularly engaged in manufacture of vaults, handholes, conduit and ducts of types and sizes specified and whose products have been in satisfactory use in similar service for not less than 3 years.

**1.05 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each type of vault, handhole, conduit, duct and appurtenance.
- C. Shop Drawings for vaults: Include plans, elevations, sections, details and accessories, including the following:
  - 1. Duct entry provisions, including locations and duct sizes.
  - 2. Cover design and vault frame support rings.
  - 3. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
  - 4. Joint details.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- B. Lift and support precast concrete units only at designated lifting or supporting points.

**1.07 COORDINATION**

- A. Coordinate layout and installation of ducts, vaults and handholes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of duct entrances into vaults and handholes with final locations and profiles of ducts as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to vaults and handholes, and as approved by A/E.

**PART 2 - PRODUCTS**

**2.01 RIGID METAL CONDUIT (RMC) AND FITTINGS**

- A. Ferrous Metal Conduit: Steel, UL 6, hot-dip galvanized.
- B. Fittings and Conduit Bodies: UL 514B, threaded galvanized.

**2.02 RIGID NON-METALLIC CONDUIT**

- A. PVC Conduit: Schedule 40, UL 651, rigid type unless indicated otherwise.

- B. Fittings: UL 651, UL 651A, UL 2420 and UL 2515.
  - 1. For electric (power) duct, 90 degree elbows with minimum 48 inch radius, factory manufactured rigid steel or Fiberglass (RTRC).
  - 2. For telecommunications service provider ducts, 90 degree elbows with minimum 48 inch radius factory manufactured rigid steel.
  - 3. For telecommunications on-site distribution ducts, 90 degree elbows with minimum 36 inch radius factory manufactured rigid steel (RMC)

#### 2.03 DUCT ACCESSORIES

- A. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
- B. Conduit Fittings at Vaults and Handhole Entrances: End Bells.

#### 2.04 PRECAST HANDHOLES

- A. Handholes: Precast concrete with open bottom unless indicated otherwise on the Contract Drawings.
- B. Rating: Rated for application where installed: AASHTO H-20 highway loading where installed in roadways and drive lanes, medium duty loading in off-street locations that are not subject to high density traffic or light duty pedestrian traffic in walkways not subject to vehicle traffic..
- C. Identification: Permanently engrave handhole covers with the system designation. Handhole designations visible from the surface.
  - 1. Electrical handhole labeled "ELECTRIC".
  - 2. Telecommunications handhole labeled "COMMUNICATIONS".
- D. Frame and Cover: Weatherproof cast iron frame. Cast iron cover with on-skid surface and lift or pull slots. Capable of being secured to the body with tamper resistant fasteners.
- E. The manufacturer's name and model number must be permanently indicated to an interior wall face.
- F. Acceptable Manufacturers: Oldcastle, Christy, Hanson, Hubbell, or approved.

#### 2.05 HANDHOLES OTHER THAN PRECAST

- A. Handholes: HDPE with an open bottom unless indicated otherwise on the Contract Drawings.
- B. Rating: Rated for light duty: pedestrian traffic. Suitable for landscape areas only.
- C. Identification: Permanently engrave handhole covers with the system designation. Handhole designations visible from the surface.
  - 1. Electrical handhole labeled "ELECTRIC".
  - 2. Telecommunication handholes designated "COMMUNICATIONS".
- D. Cover: Weatherproof with non-skid surface and lift or pull slots. Capable of being secured to the body with tamper resistant fasteners.

- E. The manufacturer's name and model number must be permanently indicated to an interior wall face.
- F. Finish: Gray in concrete or paved areas. Green in landscape areas.
- G. Acceptable Manufacturers: Oldcastle, Christy, Hanson, Hubbell, or approved

2.06 **PRECAST CONCRETE VAULTS**

- A. Vaults: Precast concrete with minimum 4,000 psi strength at 28 days. Solid bottom with recessed sump to allow for drainage, embedded galvanized channels in each wall, a 1-inch diameter ground rod knockout in the floor, pulling-in hooks, and galvanized pull/lift irons in each corner.
- B. Design: Tops and walls shall meet AASHTO H-20 highway loading, conform to ASTM C478, with 30 percent loading added for impact.
  - 1. Walls shall withstand all soil pressures, taking into consideration the soil to be encountered and groundwater level present at the site. Assume ground water level is at ground surface unless a lower water table is indicated in the boring logs.
  - 2. Designed and constructed not to float.
  - 3. Assembled Sections: Mating edges with tongue-and-groove joints. Design joints to firmly interlock adjoining components and provide waterproof junctions. Joints sealed watertight using preformed plastic strips installed in accordance with the manufacturer's instructions.
  - 4. Steel components other than reinforced steel hot-dip galvanized after fabrication.
  - 5. Identify vaults using the manufacturer's name embedded in, or otherwise permanently attached to, an interior wall face.
- C. Vault Cover Ratings: Provide per vault schedule.
  - 1. Heavy Duty Covers: Provided with H-20 rated cast iron vaults covers and a minimum of 30-inch diameter, with lift holes and provisions to secure into the vault top with fasteners. Provide Round vault covers and frames with Class 30B grey cast iron in accordance with ASTM A48.
  - 2. Medium Duty Covers: Provide with traffic rated galvanized steel hatches unless noted otherwise on the Drawings. Include a locking latch, a recessed lift handle, and a hinging system that allows the cover to open a full 180 degrees.
  - 3. Non-Traffic Covers: Provide where indicated on the Contract Drawings.
- D. Identification: Permanently label vault covers with the system designation. Vault designations visible from the surface.
  - 1. Electrical vaults labeled "ELECTRIC".
  - 2. Telecommunication vaults labeled "COMMUNICATIONS".
  - 3. Cast covers shall have the designation cast into the cover at the casting foundry. If casting the designation into the cover is not an option, the Contractor shall propose other means to permanently label the vault.
  - 4. Galvanized steel hatches shall include the bead welded designation onto the cover. If the cover cannot be bead welded, the Contractor shall propose other permanent marking options.
- E. Riser Collars: Riser collars shall match casting, concrete.

- F. Connections: Conduit entries through vertical vault walls must be through cast-in-place molded plastic duct connections such as Term-A-Ducts.
- G. Acceptable Manufacturers: Oldcastle, Hanson, or approved.

## 2.07 VAULT ACCESSORIES

- A. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
  - 1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment. Maintain 18" from corner of wall. Provide additional stanchions if spacing exceeds 30".
  - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms must be minimum 8" long with 3 arms per stanchion, with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm must be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- B. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35°F. Capable of withstanding temperature of 300°F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- C. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- D. Mechanical Duct Plugs: Duct plugs, high-impact plastic components, combined with durable elastic gaskets, are corrosion proof. Blank plug must be equipped with a rope tie device to allow the securing of pull rope to the plug's back compression plate.

## 2.08 GROUNDING

- A. Grounding: Install ground rod and bonding connections, provide as specified in Section 260526 and as indicated herein.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of ducts, vaults, and handholes with final arrangement of other utilities, site grading, and surface features as determined in the field prior to commencing work of this section.

- B. Coordination: Coordinate elevations of conduit, ducts and duct bank entrances into vaults and handholes, with final locations and profiles of conduit, ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that conduit and duct runs drain away from building to vaults and handholes, and as approved by A/E.
- C. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

### 3.03 EARTHWORK

- A. Provide as specified in Section 260510 and as indicated herein.
- B. Work with extreme care near existing utilities to avoid damage. Cut the trenches neatly and uniformly.
- C. Pitch the trenches uniformly toward vaults and handholes or both ways from high points between vaults for the required duct line drainage. Avoid pitching the ducts towards buildings.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoil, seed, sod, and/or mulch according to Division 32.
- E. Cut and patch existing pavement in the path of underground conduit and ducts according to Division 01.

### 3.04 RACEWAY INSTALLATION

- A. Install top raceway at depth shown on the Contract Drawings or minimum 24 inches below finished grade, whichever depth is deeper.
- B. Install detectable marker tape over underground raceway as specified in Section 260553. Warning marker tap must be 12 inches below finished grade directly above duct bank.
- C. Install raceway with minimum slope of 4 inches per 100 feet to drain away from building. Slope ducts from a high point in runs between two vaults to drain in both directions.
- D. Duct Entrances to Vaults: Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Cut conduit square using a saw or pipe cutter. Deburr cut ends.
- F. Bring conduit to shoulder of fittings and couplings and tighten securely.
- G. During construction, use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.
- H. Provide polyester mule tape with printed footage indicators secured at each end of each empty conduit, except sleeves and nipples. Identify with tags at each end indicating origin and destination of empty conduit. Minimum tensile strength of 1250 pounds for conduits 2-inch and smaller and 2500 pounds for conduits larger than 2-inch.

- I. Raceway bends between vaults and handholes.
  - 1. Power: No more than equivalent of three 90 degree bends
  - 2. Telecommunications: No more than equivalent of two 90 degree bends
  
- J. Underground Raceway Installation:
  - 1. Install insulated grounding bushings at conduits stubbed up or out from underground unless capped for future (spare).
  - 2. Wipe PVC conduit clean and dry before jointing. Apply full even coat of cement to entire area to be inserted into fitting. Let joint cure for minimum 20 minutes.
  - 3. Install conduit that stub up through floor at such depth that exposed conduit is vertical and no curved section of elbow is visible.
  
- K. Do not install conduit on exterior surface of building, except as shown on the Drawings and as approved by the A/E.
  
- L. Provide metallic tag with stamped raceway ID number per drawings at each conduit within each vault or handhole.

**3.05 UNDERGROUND CONCRETE ENCASED DUCT BANK INSTALLATION**

- A. Install top of duct bank at depth shown on the Contract Drawings or minimum 24 inches below finished grade, whichever depth is deeper.
  
- B. Install marker tape over underground raceway as specified in Section 260553. Warning marker tap must be 12 inches below finished grade directly above duct bank.
  
- C. Install conduit with minimum slope of 4 inches per 100 feet.
  
- D. Use suitable separators and chairs installed not greater than 4 foot on center. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement.
  
- E. Duct Entrances to Vaults: Grout end bells into structure walls from both sides to provide watertight entrances.
  
- F. Provide minimum 3 inch concrete cover at bottom, top, and sides of duct bank, concrete must be rated at 3,000 PSI.
  
- G. Stagger conduit joints in concrete encasement minimum 6 inches.
  
- H. Do not use union-type fittings without approval of the A/E.
  
- I. Construction:
  - 1. When termination of duct is not detailed on the Contract Drawings, extend conduit 1'-0" beyond concrete encasement and end cap.
  - 2. Plug and cap ends of conduit to protect from damage during construction and at end of each day's concrete pour. Protect ends of conduits not used for long periods from dirt and rodents with wooden or manufactured plugs. Non-setting mastic may be used on plug to adhere to conduit end. Drill 1/4 inch hole in lower portion of plug for drainage of conduit.

3. Swab conduits immediately upon completion of concrete pour. After cement has set, but before backfilling, pull mandrel having diameter equal to nominal conduit inside diameter, minus 1/2 inch, and not less than 12 inches long, through each conduit. Mandrel must be lead-covered or painted white to indicate protrusion inside conduit which might damage cable sheath. Attach pull string to rear end of swab mandrel to replace pull string being pulled out. When not in use, fasten pull string securely at both ends of duct.
- J. Observation: Ducts will be reviewed by the Owner's Representative before pouring concrete. The Owner's Representative will review for backfill compaction, drainage slope, spacers, floatation ties, conduit condition, and joints. Concrete shall not be poured until the observation is complete.

### 3.06 RACEWAY SCHEDULE

- A. Rigid Metal Conduit:
  1. Acceptable in all locations except as modified in this section.
  2. Where in contact with earth or concrete, install protective coating consisting of spirally wrapped 20 mil PVC tape with 1/2 inch minimum overlap - 3M Scotchrap Tape 51 or approved - or utilize PVC Coated Rigid Metal Conduit. Completely wrap and tape field joints.
- B. PVC Coated Rigid Metal Conduit:
  1. Required in corrosive environments or as indicated on the Drawings.
- C. Rigid Non-Metallic Conduit:
  1. Acceptable underground with minimum 24 inches of cover.
  2. Not acceptable for bends 45 degrees and greater unless concrete encased; utilize Rigid Metal Conduit as specified herein, PVC Coated Rigid Metal Conduit. Field bends not acceptable.
  3. Concrete encased where indicated on Contract Drawings or where required by Code or Utility.

### 3.07 HANDHOLES INSTALLATION

- A. Install precast handholes on a solid ring of base material such as concrete around the outer edge to prevent settlement. The base material shall include openings that allow drainage from the box into the soil. Boxes must be set plumb and elevated slightly above surrounding grade to prevent them from becoming the water collection points. Conduit ends must be sealed to prevent debris from entering the raceway.

### 3.08 PRECAST VAULTS INSTALLATION

- A. Install on a level bed of well-tamped gravel or crushed stone, well-graded from the 1-inch to 2-inch sieve.
- B. In paved areas, set top of vault plumb and flush with finished surface. In unpaved areas, set vault top slightly higher than surrounding area to prevent the vault from collecting surrounding water.



- C. Vaults with round castings/ covers shall have risers to recess the vault below landscaping, subgrades and other site finishes.
- D. Install a ground rod in each vault through the ground rod knockout in the floor.
- E. Install a No. 2 AWG copper bonding conductor along the perimeter of the interior walls and support above floor level. Bond all metallic parts within vault including channels, frames, lids, ladders, etc. with No. 6 AWG copper bonding jumper. Connect the ground rod to the bonding conductor with No. 2 AWG copper.
- F. In cases where Term-A-Ducts were not provided at conduit entries, fill the breakout windows with concrete or non-shrink grout from both sides after all ducts have been installed.
- G. Cast end bells into vault wall for conduit entries.

**3.09 FIELD QUALITY CONTROL**

- A. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- B. Test vault grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526.

**3.10 CLEANING**

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of vaults and handholes, including sump. Remove any foreign material.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 05 48**  
**VIBRATION ISOLATION AND SEISMIC CONTROL FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes isolation pads, spring isolators, restrained spring isolators, restraint cables, hanger rod stiffeners, anchorage bushings and washers, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards: NFPA 70, National Electrical Code (NEC).
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data:
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation and seismic restraint device.
  - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to the AHJ.
    - b. Annotate to indicate application of each product submitted and compliance with requirements.
  - 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

- C. Delegated-Design Submittal: For vibration isolation and seismic restraint details indicate to comply with performance requirements and design criteria, including analysis data signed and sealed by professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
    - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors.
    - b. Comply with requirements in other Division 26 sections for equipment mounted outdoors.
  - 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
  - 3. Field fabricated supports.
  - 4. Seismic Restraint Details:
    - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to structure during seismic events. Indicate association with vibration isolation devices.
    - c. Preapproval and Evaluation Documentation: By agency acceptable to AHJ, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- D. Welding Certificates.
- E. Test Reports:
  - 1. Field test reports.
  - 2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

**1.05 PERFORMANCE REQUIREMENTS**

- A. General: A single supplier shall furnish isolation mounts, pads, seismic restraints, sway braces, related hardware, and fabricate isolation bases for the project unless otherwise specified.
- B. Responsibility: This supplier shall be responsible for selection and installation supervision of vibration isolators. Prepare engineering drawings and details and submit to the A/E. Perform installation supervision and provide adjustment instructions.
- C. Seismic Restraints:
  - 1. Design and select restraint devices for ducts, pipes, and equipment to meet seismic requirements defined in IBC and ASCE. Prepare calculations based on coefficients included on the structural drawings. Refer to the structural drawings for allowable methods and loads.

2. Retain an engineer, specialty consultant, or seismic restraint device manufacturer to design and develop seismic restraint systems and perform calculations based on actual equipment data.
3. Engineer, specialty consultant, or seismic restraint device manufacturer shall coordinate attachments to structure to verify that attachment points on equipment and structure can accept seismic, weight, and other loads imposed. Pay any additional structural engineering services fee.
4. Shop Drawings, details, and calculations shall be stamped and signed by a professional engineer licensed in engineering in the state in which the Work is performed.

## PART 2 - PRODUCTS

### 2.01 VIBRATION ISOLATORS

- A. Manufacturers: Amber/Booth, California Dynamics Corporation, Kinetics Noise Control, Mason Industries, Vibro-Acoustics, Vibration Mountings & Controls, or approved.
- B. Isolation Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
  1. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
  2. Minimum Additional Travel: 50 percent of required deflection at rated load.
  3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4 inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
  6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
  1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed. Factory-drilled baseplate bonded to 1/4 inch thick neoprene or rubber isolator pad attached to baseplate underside. Adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  2. Restraint: Seismic or limit-stop as required for equipment and AHJ.
  3. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
  4. Minimum Additional Travel: 50 percent of required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.02 SEISMIC RESTRAINT DEVICES

- A. Manufacturers: Amber/Booth, California Dynamics Corporation, Cooper B-Line, Hilti, Mason Industries, TOLCO, Unistrut, or approved.
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements as defined in reports by an agency acceptable to AHJ.
  - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components minimum 4 times maximum seismic forces to which they will be subjected.
- C. Restraint Cables: ASTM A 603 galvanized steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service. Include minimum 2 clamping bolts for cable engagement.
- D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchors and studs.
- F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices.
- G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene with a flat washer face.
- H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of 8 times diameter.
- I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 APPLICATIONS**

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to the AHJ.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces. Welding stiffeners to rods not acceptable.
- C. Strength of Support and Seismic Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

**3.05 SEISMIC RESTRAINT DEVICE INSTALLATION**

- A. Equipment and Hanger Restraints:
  - 1. Install restrained isolators on electrical equipment.
  - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 3. Install seismic restraint devices using methods approved by agency acceptable to AHJ providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall mounted equipment, arranged to provide resilient media where equipment or equipment mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated on the Drawings, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, and at concrete members.
- D. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the A/E if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, and grout has achieved full design strength.
  - 3. Mechanical Anchors: Protect threads from damage during anchor installation. Install sleeve anchors with sleeve fully engaged in structural element to which anchor is to be fastened.
  - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from bottom of hole and progressing toward surface in such a manner as to avoid introduction of air pockets in adhesive.
  - 5. Set anchors to manufacturer's recommended torque using a torque wrench.

**3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION**

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections and branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

**3.07 FIELD QUALITY CONTROL**

- A. Tests and Inspections:
  - 1. Obtain the A/E's approval before transmitting test loads to structure. Install temporary load-spreading members.
  - 2. Test at least 4 of each type and size of installed anchors and fasteners selected by the A/E.
  - 3. Test to 90 percent of rated proof load of device.
  - 4. Measure isolator restraint clearance.
  - 5. Measure isolator deflection.
  - 6. Verify snubber minimum clearances.
  - 7. If a device fails test, modify installations of same type and retest until satisfactory results are achieved.
- B. Remove and replace malfunctioning units, provide new, and retest as specified above.
- C. Prepare test and inspection reports. Include copy of reports in the Operation and Maintenance Manual.

**3.08 ADJUSTING**

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 05 53  
ELECTRICAL IDENTIFICATION**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes nameplates, wire and cable markers, conduit color coding, buried duct marking tape, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards: NFPA 70, National Electrical Code (NEC).

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Nameplate schedule.

**PART 2 - PRODUCTS**

**2.01 IDENTIFICATION MATERIAL**

- A. Nameplates:
  - 1. Engraved three-layer laminated plastic.
    - a. Normal Power: White letters on black background.
    - b. NEC 700 System - Emergency Power: White letters on orange background.
    - c. NEC 702 System - Optional Standby Power: White letters on green background.
  - 2. Panelboards and Switchboards: 1/2 inch high letters to identify equipment designation. 1/4 inch high letters to identify voltage rating and source.
  - 3. Control Panels and Equipment (Lighting and Receptacle Control): 1/2 inch high letters to identify equipment designation. 1/4 inch high letters to identify source, control panel name and space and zone controlled as designated on the Drawings..



4. Enclosed Circuit Breakers, Disconnect Switches, Motor Starters: 1/4 inch high letters to identify load served and source.
  5. Transformers: 1/2 inch high letters to identify equipment designation as indicated on the Drawings. 1/4 inch high letters to identify primary and secondary voltages, primary source, and secondary load and location.
  6. Power Monitoring: 1/2 inch high letters to identify meter designation. 1/4 inch high letters to identify metering category.
  7. Automatic Transfer Switches: 1/2 inch high white letters to identify equipment designation, voltage rating, normal source, standby source and load served and location.
  8. Emergency/Standby Power Boxes and Enclosures larger than six inches by six inches. 1/2 inch high letters to identify equipment and source designation.
  9. Service Entrance Equipment: 1/2 inch high letters to identify available fault current.
  10. Digital Control Switches: 1/4 inch engraved letters on push button or cover to identify control zone.
  11. Feeders: 1/4 inch high letters to identify feeder ampacity, phase conductor size and quantity.
- B. Adhesive Printed Labels:
1. Laminated tape – Brother TZe Series 12 mm width tape or equivalent with adhesive back suitable for exterior locations.
    - a. Normal Power: Black letters on clear background.
    - b. NEC 700 System Emergency Power: Orange letters on white background.
    - c. NEC 702 System Emergency Power: Green letters on white background.
  2. Switches: 1/4 inch letters to identify load controlled.
  3. Receptacles: 1/4 inch letters to identify panelboard, circuit number and where identified as Dedicated, identify equipment designation as shown on panel schedule
  4. Lighting control devices: 1/4 inch letters to identify lighting control device designation as shown on shop drawings and lighting control program
- C. Outlet boxes, junction boxes and pull boxes for emergency system devices and circuits orange in color, both inside and outside.
- D. Outlet boxes, junction boxes and pull boxes for fire alarm system devices and conductors: red in color, both inside and outside.
- E. Permanent felt marker for junction and pull box.
1. Normal/Standby/Emergency Power: Black letters indicating circuit notation.
  2. Lighting controls: Black letters indicating “Lighting Control Device” and relays
- F. Wire and Cable Markers:
1. Split sleeve or tubing type. Vinyl impregnated cloth, vinyl, and mylar self-adhesive types not acceptable.

2. Color code wire in accordance with the coding shown in Decal Detail below. Conductors of power systems in this building (plant) are identified as follows:

Conductor	208Y/120 Volt	480/277 Volt
A Phase (Left Bus In Panel):	Black	Brown
B Phase (Center Bus In Panel):	Red	Orange
C Phase (Right Bus In Panel):	Blue	Yellow
A Phase (Isolated Ground Circuit):	Black with yellow stripe	N/A
B Phase (Isolated Ground Circuit):	Red with yellow stripe	N/A
C Phase (Isolated Ground Circuit):	Blue with yellow stripe	N/A
Neutral:	White	Gray
Equipment Ground:	Green	Green
Isolated Ground:	Green with yellow stripe	N/A

3. Where dedicated neutral conductors are provided for single phase circuits, neutral conductor shall have a colored stripe to match the color of the corresponding phase conductor.
- G. Phase Identification: Vinyl colored electrical tape.
- H. Detectable Buried Duct Marking Tape:
1. Electrical (Power) Ducts: Six inch wide red tape with words "CAUTION - ELECTRIC LINE BURIED BELOW". 3M Scotch #408 or approved.
  2. Communications/Telephone Ducts: Six inch wide orange tape with the words "CAUTION - TELEPHONE LINE BURIED BELOW". 3M Scotch #411 or approved.
- I. Electrical Hazard Marking Tape: Black and yellow striped vinyl 2 inch wide hazard tape, Identi-Tape #VH2BKY or equal.
- J. Directory Cards: Directory cards shall consist of heavy cardstock, metallic mounting frames and plastic covers. Mounting frames attached to the back side of panelboard or lighting control panel doors. Directories shall contain typewritten text indicating the circuit breaker or control relay number, type of load served and room number in which each load is located. Unused circuit breakers or control relays designated with "SPARE" written in pencil. Spaces for future circuit breakers left blank. Circuit designations on directory cards shall match the installed conditions with respect to loads and physical arrangement within panelboards.
- K. Wiring Color Code Schedules: Prepared using a color printer and laminated between two layers of clear plastic. Schedules shall show color designation for each phase, neutral and ground of each system voltage. Schedule size, 130 mm by 180 mm (5" by 7").
- L. Arc Flash Hazard Safety Signs: Product safety signs in accordance with ANSI Standard Z535.4 requirements. An electrical hazard (lightning) graphic surrounded by a yellow triangle at the left of each sign. At the top of the right side of the sign, in an orange signal word block, the signal word "Warning" shall appear together with an exclamation mark surrounded by a triangle. Underneath the signal word block, include the message "Arc Flash Hazard" printed on the first line, followed by "Available Fault Current" and "Appropriate PPE Required" on the second line. The sign shall also indicate the flash protection boundary in inches and the incident energy at 460 mm (18") in cal/cm<sup>2</sup>, in accordance with the requirements of NFPA 70E.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. Description: Install, apply, erect, and perform work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, more stringent requirements govern.
- B. Nameplates:
  - 1. Degrease and clean surfaces to receive nameplates.
  - 2. Install nameplates parallel to equipment lines.
  - 3. Secure nameplates to equipment fronts using screws or rivets. Adhesives not acceptable.
- C. Wire Identification:
  - 1. Install wire markers on conductors in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
  - 2. Install solid colored jackets for wire sizes smaller than number 8 AWG. Wire sizes larger than number 10 AWG may be taped at both ends and at pull and junction boxes with appropriate colored tape. Color coding tape to completely encircle conductor at least 3 inches wide.
- D. Felt Marker Identification: Apply on front of cover in non-finished areas, such as mechanical/electrical rooms, above ceilings, and similar locations, and on back of cover in finished areas.
- E. Provide black and yellow striped vinyl 2" wide hazard tape on floor and stencil "Electrical Hazard-Keep Clear" on floor, spaced as to not exceed 4 feet on center to identify code required clearance in front of electrical equipment including switchboards, panelboards, motor control centers, transformers, transfer switches, etc. in unfinished spaces such as electrical and mechanical rooms.

### 3.04 INSTALLATION

#### A. General:

1. Provide identification for electrical equipment as specified herein.
2. Attach identification in durable manner, suitable to each respective type of identification. Securely fasten nameplates to equipment with two (2) rivets. Wiring color code schedules fastened to equipment with permanent adhesive.

#### B. Distribution Panelboards and Switchboards: Provide the following nameplates and schedules.

1. Nameplates: Provide for each distribution panelboard and switchboard. Install nameplates on the outside of the equipment enclosures above the incoming line sections.
2. Overcurrent protective device nameplate: Install nameplates on the outside of the equipment enclosure adjacent to each device.
3. Wiring color code schedule: attach to the exterior of each switchboard and each distribution panelboard. Locate schedules adjacent to the main incoming line sections.
4. Feeder nameplate: attach to the exterior of each switchboard and distribution panelboard to identify the source feeder.

#### C. Panelboards: Provide the following nameplates and schedules

1. Panelboard nameplate: Provide for each panelboard. Install nameplates on the outside of panelboard enclosures above doors.
2. Directory cards: Provide in each panelboard. Update room numbers and descriptions to match final Owner approved room name/number. Place directory card in holder behind plastic cover.
3. Provide a reduced copy of each panel schedule contained in the Contract Documents, showing actual configuration. Provided panel schedules in addition to the typewritten panelboard directories. Place schedules in directory frame.
4. Provide a wiring color code schedule attached to each panelboard. Install schedules on the inside of panelboard doors.
5. Provide a feeder tag nameplate attached to the exterior of each panelboard to identify the source feeder

#### D. Control Panels/Equipment:

1. Nameplate: attach to the outside, front of enclosure for each relay panel, control units and control equipment. Nameplate text shall include the relay panel name or space and zone controlled as designated on the Drawings.

#### E. Provide an arc flash hazard safety sign attached to equipment indicated in power studies. Locate signs so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. On panelboards located in mechanical and electrical rooms, attach the signs on the outside of panelboard enclosures. On all other panelboards, attach the signs on the dead fronts or the back side of the panel doors, so that signs are not visible when panelboard doors are closed.

#### F. Dry-type Transformers:

1. Nameplate: attach to the outside, front of each dry-type transformer enclosure. Nameplate text shall include the transformer name as designated on the Drawings.

2. Feeder tag nameplate: attach to the exterior of each dry-type transformer to identify the source feeder
- G. Power Monitoring:
1. Nameplate: attach on the outside, front of each power meter enclosure. Nameplate text shall include the meter name/number and metering category/load description as designated on the Drawings.
- H. Motor Starters:
1. Provide a nameplate on the outside, front of each starter and variable frequency drive enclosure. Nameplate text shall include the name of load served as designated on the Drawings.
- I. Signaling and Communications Systems Cabinets:
1. Provide a nameplate on the outside of each cabinet above door. Nameplate text shall include the system name as designated on the Drawings and the cabinet function.
- J. Disconnect Switches:
1. Provide a nameplate on the outside front of each disconnect switch enclosure. Nameplate text shall include the name of the load controlled as designated on the Drawings, and also the designation of the equipment that serves as the power source for the circuit that supplies the disconnect.
  2. Provide a feeder tag nameplate attached to the exterior of each disconnect that has overcurrent protection to identify the source feeder
- K. Relays and Time Switches:
1. Provide a nameplate on the outside front of each relay and time switch enclosure. Nameplate text shall include the name of the load controlled as designated on the Drawings.
- L. Contactors:
1. Provide a nameplate on the outside front of each contactor enclosure. Nameplate text shall include the contactor name as designated on the Drawings and the name of the load controlled.
- M. Control Switches:
1. Provide a nameplate for each equipment control switch with a device plate as specified in Section 262726. Nameplate text shall include the name of the load controlled as designated on the Drawings.
  2. Provide a nameplate or printed label on each control switch that does not have a device plate as specified in Section 262726. Verify type with the Owner. Text shall include the name of the load controlled as designated on the Drawings.

N. Wiring Devices:

1. Receptacle Labels:

a. Indicate panelboard and circuit number.

2. Provide an engraved printed label for each switch that controls luminaires not within sight of the switch or that controls receptacles. Engraved printed label text shall include the type and location of the load controlled.

O. Junction Boxes and Pull Boxes:

1. Provide nameplates on the outside of the front cover of junction boxes and pull boxes in finished areas and of junction boxes and pull boxes that are larger than 150 mm by 150 mm (6" by 6"). Nameplate text shall designate the system for which wiring is to be enclosed in the box. In the case of power system junction boxes or pull boxes, the nameplate text shall also include the panelboard name and circuit number.

2. Junction boxes and pull boxes 150 mm by 150 mm (6" by 6") or smaller in unfinished areas and above accessible ceilings must be color coded by spray painting the outside edges of the box and spray painting the cover with the following colors:

208Y/120 VAC Power:	Unpainted
480Y/277 VAC Power:	Tan
Fire Alarm & Detection:	Red
Security and Video Surveillance:	Purple
Telecommunications:	Blue
Intercom/Paging & Clock:	White
Television:	Black
Audio-video:	Gold
High Voltage – 600V and higher:	Yellow
NEC 700 Emergency System	Orange
NEC 702 Optional Standby System	Green

3. After painting, mark the covers of power system junction boxes and pull boxes with the panelboard name and circuit numbers. Marking must be done with a wide-tip, permanent-ink black marker.

P. Outlet Boxes:

1. Outlet boxes for emergency power and fire alarm circuits must be color coded by spray painting the box inside and outside with the following colors:

Fire Alarm & Detection:	Red
NEC 700 Emergency System	Orange

Q. Raceway systems:

1. NEC 700 Emergency Power: Provide adhesive label at intervals not exceeding 25 feet. Orange with black letters, "EMERGENCY SERVICE" Brady #44328 or approved. Where outlet boxes or enclosures are encountered within 25 feet, label not required.

R. Vaults and Handholes:

1. Provide identification at vault/handhole covers and each raceway per Section 260543.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 05 73  
ELECTRICAL POWER STUDIES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes preparation of fault (short-circuit) calculations, protective device coordination study, and arc flash hazard analysis and labeling.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. IEEE C57.109, IEEE Guide for Transformers Through-Fault Current Duration.
  - 2. IEEE 141, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book).
  - 3. IEEE 241, IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (IEEE Gray Book).
  - 4. IEEE 242, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book).
  - 5. IEEE 1584, IEEE Guide for Performing Arc-Flash Hazard Calculations.
  - 6. NFPA 70, National Electrical Code.
  - 7. NFPA 70E, Standard for Electrical Safety in the Workplace.
  - 8. ANSI Z535.4, American National Standard for Product Safety Signs and Labels.
- C. Qualifications: Fault calculations, protective device coordination study and arc flash hazard analysis shall be prepared by electrical equipment manufacturer who furnishes incoming service equipment to building or an independent electrical engineer. In either case, calculations and study shall be stamped and signed by a professional engineer licensed in the state in which the Work is performed.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.



- B. Product Data: Identification of computer software program used for study.
  - 1. Utility owned transformer:
    - a. Utility transformer nameplate information: size, rating, overcurrent protection, impedance, X/R.
    - b. Available fault duty on secondary side of transformer.
    - c. Nearest upstream protective device type/size/settings.
    - d. Conductor size/type, number of parallel runs and distance from Point of Service back to nearest upstream protective device.
- C. Submit study outline.
- D. Initial Submittals:
  - 1. One-line diagram with each bus and node having a unique number indicating that fault calculation will be made at that point.
  - 2. Representative one-line diagram of distribution system (with bus numbers as described herein) indicating which devices will be presented in protective device coordination study.
- E. Following review and approval of the initial submittals by the A/E, submit final calculations and study in a common bound report.
- F. Closeout Submittals:
  - 1. Final report, in the following formats:
    - a. Hard copy, bound.
    - b. Soft copy, PDF format.
    - c. Soft copy, native file(s) in format utilized by computer software program.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this section. Manual calculations are unacceptable.
- B. The fault calculations protective device study and arc flash hazard analysis must include complete fault calculations for each proposed and ultimate source combination.
- C. Source combinations may include present and future power company supply circuits, large motors, and generators.
- D. Drawings and specifications indicate general requirements for electrical equipment being provided. Changes and additions may be suggested by results of study. Submit proposed changes and additions as a part of study.

## 2.02 FAULT (SHORT CIRCUIT) CALCULATIONS

- A. Prepare description of calculation methods, assumptions, and base per unit quantities selected.
- B. Prepare one-line diagram(s) and source impedance data including X/R ratio and power company system characteristics.
- C. Prepare impedance diagrams, typical calculations, tabulations of calculation quantities, and results, conclusions, and recommendations.
- D. Prepare calculations of short circuit interrupting and momentary (when applicable) duties for an assumed 3 phase, bolted, fault at medium voltage switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear or switchboard lineup, motor control center, distribution panelboard, branch circuit panelboard, and other significant locations throughout system.
- E. Prepare ground fault current calculations for the same system areas including associated zero sequence impedance diagram.
- F. Prepare tabulations including fault impedance, X/R ratios, asymmetry factors, motor contributions, short circuit KVA, and symmetrical and asymmetrical fault currents.

## 2.03 PROTECTIVE DEVICE COORDINATION STUDY

- A. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- B. Prepare time-current coordination curves graphically indicating proposed. Include upstream and downstream devices associated with each device to illustrate coordination. Include with each curve sheet a complete title and one-line diagram with legend identifying specific portions of system covered by that particular curve sheet.
- C. Study shall incorporate all system protective device components.
- D. Include detailed description of each protective device identifying its type, function, manufacturer, AIC rating, device tap, time-dial, pick-up, instantaneous, and time-delay settings.
- E. Include on curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low voltage equipment circuit breaker and fuse characteristics, pertinent transfer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices.
- F. Include, as a minimum, devices down to largest branch circuit and largest feeder circuit breaker in each piece of electrical gear or equipment.
- G. Include recommended adjustable settings of overcurrent protective devices including but not limited to the following:
  - 1. Circuit breakers.
  - 2. Protective relays.
  - 3. Ground fault protection.

4. Zone selective interlocking.
- H. Include manufacturing tolerance and damage bands in plotted fuse characteristics.
- I. Show transformer full load, 150, 400, and 600 percent current, transformer magnetizing inrush, transformer withstand parameters according to IEEE C57.109, and significant symmetrical or asymmetrical fault current to which device is exposed.
- J. Select each primary protective device required for transformer winding configuration shown so that its operating band is within transformer characteristics including point equal to 59 percent of IEEE C57.109 to withstand point for secondary line-to-ground fault protection. Where primary device is not within transformer characteristics, show transformer damage curve.
- K. Separate transformer primary protective device characteristic curves by a 16 percent current margin for coordination and protection in event of secondary line-to-line faults. Separate medium voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.
- L. Prepare complete sets of individual protective device time-current coordination characteristics on transparencies.

#### 2.04 ARC FLASH HAZARD ANALYSIS AND LABELING

- A. Perform electrical arc flash hazard analysis in accordance with the latest adopted version of NFPA 70E and IEEE 1584 to calculate arc flash protection boundary, working distance, incident energy level and personal protective equipment (PPE) requirements. Arc flash analysis and labeling shall be performed for electrical distribution system equipment including switchboards, panelboards, uninterruptible power supplies, transfer switches, industrial control panels, motor control centers, transformers, enclosed circuit breakers and disconnect switches.
- B. Provide arc flash hazard safety signs in accordance with Section 260553, Electrical Identification. Arc flash signs shall include the following information.
  1. Equipment name.
  2. Working distance.
  3. Incident energy level.
  4. Arc flash hazard boundary.
  5. Required PPE level.
- C. Where arc flash energy reduction devices are utilized, provide second set of arc flash labels reflecting information when arc flash reduction devices are implemented. Labels shall be visibly different from standard labels for easy identification.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine project overcurrent protective device submittals for compliance with fault calculation study, electrical device coordination and arc flash hazard labeling requirements and other conditions affecting performance.

- B. Existing Condition Survey: Field investigate existing conditions to provide the information required for a complete power study from the Point of Service to all new and existing to remain equipment.
  - 1. Serving utility information: Contact the utility to get all information upstream of the point of service required to perform the power study.

**3.02 EQUIPMENT SHORT CIRCUIT CURRENT RATING**

- A. All mechanical equipment, packaged systems, control panels, motor starters, motor controllers, variable frequency drives and similar equipment shall carry a Short Circuit Current Rating (SCCR) equal to or greater than the available fault current delivered from the electrical system. Coordinate final available fault currents with the contractors providing this equipment.

**3.03 ADJUSTING**

- A. After review by the A/E, make revisions to protective device settings to accomplish conformance with approval fault calculations and protective device coordination study. Provide final settings of all adjustable overcurrent devices in accordance with the coordination study.

**3.04 LABELING**

- A. Provide arc flash hazard labels on all electrical equipment. Labels shall be located so as to be clearly visible to personnel providing examination, adjustment, servicing or maintenance of the equipment.

**3.05 DEMONSTRATION**

- A. Demonstrate to the A/E that correct device settings and ratings have been made. Include settings and ratings on the Record Drawings.
- B. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels. Training should include how to use arc flash energy reduction devices to reduce the available arc flash energy at switchboards.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 08 10  
ELECTRICAL TESTING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes testing requirements for individual components, equipment, systems, and integration to ensure intended facility operation. Test equipment per manufacturer guidelines and industry standards. Test modes of operation and interlocks and alarm functions. This section presents a guideline of system testing. Provide complete, comprehensive testing in addition to minimum requirements specified in individual sections and in this section.
- B. Training: Include comprehensive Owner operation and maintenance training of individual components, equipment, and systems. Training includes normal operation and alternate modes of operations.
- C. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ANSI/NETA ATS 2017, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
  - 2. ANSI/NETA MTS-2015, Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems.
  - 3. NFPA 70B, Recommended Practice for Electrical Equipment Maintenance.
  - 4. NFPA 70, National Electrical Code (NEC).
- C. Testing Agency: Testing shall be accomplished by an approved testing agency. Retain services of a NETA certified firm or approved. Testing agency shall not be associated with manufacturer of equipment or systems under test.
- D. Perform testing and inspections with the assistance of a factory-authorized service representative, where indicated in individual specification sections.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.

- B. Qualifications: Testing agency qualifications.
- C. Testing Plan and Schedule: Detailed plan and schedule of testing, and training for acceptance by the Owner and the A/E prior to initiation of work.
- D. Test Procedures: Test procedures and sample test forms.
- E. Test Reports: Submit detailed report of testing functions with associated results. Include date of testing and corresponding line item for system tested and individual components. Include testing checklists for each system and device tested. Record for each line item test results that comply with requirements. Record for each line item test results that do not comply with requirements, corrective actions taken to achieve compliance with requirements and retest date and confirmation.
- F. Settings of Adjustable Devices: Record as-left set points of all adjustable devices.
- G. Include copy of reports in the Operation and Maintenance Manual.
- H. Certification: Certification that tests have been completed.

## PART 2 - PRODUCTS

Not used.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

### 3.04 GENERAL

- A. Perform acceptance tests in accordance with manufacturer's recommendations, NFPA 70 and ANSI/NETA ATS.

- B. Report any system, material, or workmanship which is found defective on basis of electrical inspections and tests to the A/E.
- C. If test reveals a fault or problem, remove and replace malfunctioning units. Repeat entire test until problem is corrected. Submit additional written test reports.
- D. Maintain written record of tests. Upon completion of project, assemble and certify final test report and include in the Operation and Maintenance Manual. Compile field test reports signed by individuals performing the tests.

### 3.05 GENERAL COMPONENT AND EQUIPMENT TESTING REQUIREMENTS

- A. Phase Relationship Tests: Check connections to existing and new equipment for proper phase relationship. During such check, disconnect devices which could be damaged by application of voltage or reversed phase rotation.
- B. Grounding:
  - 1. Test each ground electrode system. Comply with requirements in Sections 260526 and 260527.
  - 2. Visual and Continuity Test: Perform for each of the following ground connections:
    - a. Equipment ground connections.
    - b. Cable tray grounding.
- C. Feeders:
  - 1. After installation and prior to energization, test cable and wire for continuity of circuitry and for short circuits, Megger circuits of 100 Amp and greater. Correct malfunctions. Submit record of megohmmeter readings to the A/E.
  - 2. Inspect wire and cable for physical damage and proper connection.
  - 3. Inspect ground conductor's installation to ensure ground terminations, jumpers, and devices have solid, mechanical connection.
  - 4. For circuits above 80 Amps, perform torque test for each conductor termination. Torque connections per manufacturer's recommendations and tabulate results.
- D. Overcurrent Protective Device Calibration: Perform necessary field settings and adjustments to conform to the coordination study specified in Section 260573.
- E. Overcurrent Protective Device Factory Tests: Submit documentation of factory testing of distribution circuit breakers as specified in Section 262813.
- F. Switchboards:
  - 1. Perform overcurrent device, conductor, terminations, and thermographic testing described in this section.
  - 2. Inspect equipment for signs of damage.
  - 3. Verify installation per the Drawings.
  - 4. Inspect cabinets for foreign objects. Clean exterior and interior of cabinets from dirt and dust.
  - 5. Check control wiring connections for tightness.
  - 6. Check power wiring connections for tightness.

- G. Panelboards:
1. Inspect for physical damage, proper installation, supports, and grounding.
  2. Inspect cabinets for foreign objects. Clean exterior and interior of cabinets from dirt and dust.
  3. Verify neutrals are grounded only at main or separately derived service point.
  4. Check load balance of panelboards for load balance between phases and make adjustments to bring phases within 15 percent of average load.
- H. Transformers:
1. Inspect for physical damage, proper installation, supports, and grounding.
  2. Inspect enclosure for foreign objects. Clean exterior and interior of enclosure from dirt and dust.
  3. Verify grounding system is installed.
  4. Verify phase connections.
  5. Check power wiring connections for tightness.
  6. Check and record secondary voltages and adjust as necessary.
- I. Thermographic Testing:
1. Perform thermographic survey of terminations made in switchgears, switchboards, panelboards, disconnect switches, UPS, PDUs, transformers, and generators. Provide temporary load as required during testing.
  2. Correct terminations and replace equipment found to be ineffective during the survey.
  3. Re-inspection is required for each item not corrected at time of original inspection with verification of correction.
  4. Prepare thermographic inspection report. Include:
    - a. List time, equipment or panel, anomaly location, ambient temperature, measured temperature, temperature rise, breaker rating, and measured load in amps, percent load, and probable cause.
    - b. List anomalies with photographs and note correction action taken or required.
    - c. Affix label to each tested item affirming successful completion of test. Label shall indicate date of survey and name and phone number of testing agency.
- J. Receptacles: Test for open ground, reversed polarity, open hot, open neutral, hot and ground reversed, and hot on neutral.
- K. Lighting Controls: Test per Section 260923.
- L. Power Monitoring System: Test per Section 260913.
- M. Package Generator, Transfer Switch, Load Bank: Test per Sections 262313 and 263600.
- N. UPS System: Test per Section 263353.



3.06 **REPORTS**

A. Prepare test reports for each system, equipment and device tested. Include copy of each test report in the Operation and Maintenance Manual. Utilize test forms for systems and equipment tested. Use manufacturer's standard or other appropriate test forms commensurate with test performed. Test reports shall include the following.

1. Summary of project.
2. Description of equipment tested.
3. Description of test.
4. Test results including retesting results.
5. Test dates.
6. Tester's name.
7. Witnesses (when required).
8. Corrective work.
9. Acceptance criteria.
10. Conclusions and recommendations.
11. Appendix including appropriate test forms.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 09 23  
LIGHTING AND RECEPTACLE CONTROLS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes design, furnish, and install of interior lighting and plug load control systems and site lighting control systems required to form complete coordinated system(s) ready for operation. Contract Documents indicate minimum scope and performance criteria. It is the responsibility of the lighting controls manufacturer/vendor/contractor to provide a complete system.
- B. Digital lighting controls: Networked energy saving intelligent lighting control system including lighting control panels, network interface modules, emergency lighting transfer devices, as well as digital wall switches, occupancy sensors, daylighting controls, and associated appurtenances.
- C. Receptacle/Plug load controls: Plug load control devices including contactors and relays.
- D. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. NEMA 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts.
  - 2. NFPA 70, National Electrical Code (NEC).
  - 3. UL 508, Standard for Industrial Control Panels.
  - 4. UL 916, Standard for Energy Management Equipment.
  - 5. UL 917, Standard for Clock Operated Switches.
  - 6. UL 924, Standard for Emergency Lighting and Power Equipment.
  - 7. Washington State Energy Code
- C. Comply with NEC, NEMA, and FCC emission requirements for Class A applications.
- D. UL Approvals: Relay panels and accessory devices UL listed and labeled under UL 916. Custom relay panels UL listed and labeled under UL 508. Automatic load control relays UL listed and labeled under UL 924. Branch Circuit Emergency Lighting Transfer Switch UL listed and labeled under UL 1008.

- E. Certification: Manufacturer shall certify that products will meet product specifications and local energy codes. If any additional equipment is required to meet coverage patterns and local energy codes, provide additional equipment at no additional cost to the Owner.

#### 1.04 DESIGN/PERFORMANCE REQUIREMENTS

- A. Design, furnish, and install complete operable lighting control system(s) in accordance with the latest adopted editions of energy code and Owner requirements.
- B. Drawings reflect minimum Owner requirements. The Contractor's scope of work shall include but not limited to the following:
  - 1. Complete lighting control system based on the available architectural, civil, structural, mechanical and electrical drawings.
  - 2. Wiring systems associated with lighting controls.
  - 3. Providing additional occupancy sensors, photo sensors, daylight sensors, low voltage switches, relays, dimming modules, UL 924 control devices, control panels, and power supplies associated with lighting controls.
- C. Networked digital lighting controls shall accommodate the square-footage coverage requirements for each space controlled as indicated on the lighting zone control plans. Provide relays, control modules, dimming modules, occupancy sensors, switches, daylighting sensors, astronomical timeclock, networking equipment and cabling, plug/load relays and controllers and accessories that suit the required lighting and electrical system parameters.

#### 1.05 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of lighting control system and components. Include digital cable, termination types, wire connectors, manufacturer specific back boxes/supporting equipment.
- C. Shop Drawings:
  - 1. Floor plans showing wall occupancy sensors, light switches, relays, plug/load controllers, power supplies, dimming module and network controller locations. Include typical installation and mounting diagrams. Above ceiling devices to be shown on the floor plans.
  - 2. Reflected ceiling plans showing occupancy sensors, daylighting sensor. Include typical installation and mounting diagrams for occupancy and daylighting control devices.
  - 3. Detailed point to point wiring diagrams.
  - 4. System one-line diagram showing panels, number and types of switches and sensors, and building energy management system interface.
  - 5. Request for engraved switch verbiage
  - 6. Drawings for each panel showing hardware configuration and numbering.
  - 7. Panel wiring schedules.
  - 8. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
  - 9. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

- D. Commissioning/Test Reports:
  - 1. Field Test Reports.
  - 2. Commissioning Plan with Test Procedures.
  
- E. Closeout Submittals:
  - 1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
  - 2. Operation and Maintenance Manual:
    - a. Include approved Shop Drawings and Product Data.
    - b. Engraved switch identification.
    - c. Include Sequence of Operation, identifying operation for each room/ space and accent lights.
    - d. Include manufacturer's maintenance information.
    - e. Operation and Maintenance Data: Include detailed information on device programming and setup.
    - f. Include startup training and test reports.

**1.06 PROJECT CONDITIONS**

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

**1.07 WARRANTY**

- A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Interior and Exterior Building Mounted Fixture Lighting Controls: Acuity n-Light Air.
  
- B. Site Lighting Controls: Hubbell NX wireless control system or equal.

2.02 INTERIOR AND BUILDING MOUNTED LIGHTING CONTROLS

A. System Description

1. Space Control System: Electrically operated, electrically supervised, lighting control system as described herein. Include control units, power supplies, relays, dimming output control devices, input control devices including occupancy sensors, photo sensors and control switches, wiring, cabling, conduit, fittings, and accessories required for a complete operating system.
2. System Types (indicated in the contract documents):
  - a. Digital control: Digital controllers for lighting zones, fixtures and/or plug loads. Provide controllers to match the lighting and plug load control requirements. System, control, and features include:
    - 1) Stand-alone digital control system: Digital control within a single space to bind room loads to the connected control devices in the space. Control functions are limited to the devices connected to the stand alone digital control system.
      - a) Self-configuring digital controller(s) with all digital parameter data programmed into non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
    - 2) Networked digital control system: Digital control of devices visible through the network and capable of complete system control including scheduling, room device parameter administration, power monitoring, and reporting device status. The network will have a single user interface point to program or administer the system.
    - 3) Digitally addressable control devices:
      - a) On/Off control relays.
      - b) Dimming control devices: 0-10V, phase dimming.
      - c) Plug load control relays.
      - d) Tunable control devices.
    - 4) Digital inputs:
      - a) Occupancy sensors.
      - b) Photo sensors.
      - c) On/Off/Scene and dimming control switches.
      - d) Partition sensors.
    - 5) Configuration tools: Allows complete configuration and reconfiguration of the Space. Must be able to tune system without the use of ladders.
3. Comply with requirements in Section 260533 for raceways, Section 260519 for conductors and wiring, Section 260534 for outlet boxes, and Section 260529 for supports. System cabling requirements shall meet manufacturer standards.
4. Open cabling methods may be utilized above accessible ceilings. All cabling in exposed areas, above inaccessible ceilings and in walls shall be installed in raceway.

5. Control: The system shall have control devices to perform automatic and/or manual control functions indicated on the drawings and defined below. The system shall also be capable of providing sequence of operations functions indicated on the drawings.
- a. Occupancy Sensor Control: Provide occupancy sensors for on/off control with manual dimming of light fixtures in as indicated on drawings. Control shall function as vacancy sensors with Manual-ON functionality or occupancy sensors with Automatic-ON functionality.
  - b. Dimming Control Requirements: Provide automatic dimming for each light fixture in daylight areas and manual dimming zones as indicated on lighting zone control drawings.
  - c. Manual On/Off Control: Provide control devices to turn on/off all light fixtures within manual control zones as indicated in the drawings.
  - d. Daylighting Control Requirements: Provide daylight-responsive automatic control in all spaces where daylight contribution is available as defined by relevant local building energy code. See lighting control zone drawings for additional information:
    - 1) All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylighting zones.
    - 2) Daytime set points for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with drawings and specifications.
    - 3) Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system shall be designed to turn off electric lighting when daylight is at or above required lighting levels. Daylighting control system shall turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
  - e. Timeclock Control Requirements: Provide astronomical timeclock for on/off control based on time of day as indicated in drawings.
  - f. Plug Load control requirements: Provide control devices to energize/de-energize controlled receptacles as indicated in the drawings. Controlled receptacles are non-essential plug loads in spaces as required by the applicable energy code.
  - g. Egress Lighting Control: Provide dedicated control devices for all egress lights within each control zone indicated in the drawings.

B. System Operation

1. Digital Control System shall include the following features:
- a. Occupancy Sensors: Digital wall/ceiling device or digital wall switch.
    - 1) Calibration and configuration for the following variables:
      - a) Sensitivity: 0-100 percent in 10 percent increments.
      - b) Time delay: 1-30 minutes in 1 minute increments.
      - c) Test mode: Five second time delay.
      - d) Detection technology: PIR, Dual Technology activation and/or re-activation.
      - e) Walk-through mode.

- 2) Programmable control functionality including:
    - a) Each sensor may be programmed to control specific loads within a local network.
    - b) Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
    - c) On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use one of both technologies. Technologies include:
      - d) Ultrasonic or Microphonic.
      - e) Passive Infrared.
  - 3) Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal Hours (NH) and After Hours (AH) time periods.
  - 4) Cable or wiring connections as required by the lighting controls systems.
  - 5) Device Status LEDs including:
    - a) PIR detection.
    - b) Ultrasonic or Microphonic detection.
    - c) Configuration mode.
  - 6) Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
  - 7) Manual override of controlled loads.
- b. Dimming Control:
- 1) Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
  - 2) The following dimming attributes may be changed or selected using a network interface or wireless configuration tool:
    - a) Establish preset level for each load from 0-100 percent.
    - b) Set high and low trim for each load.
    - c) Normalize dimming curve for main ambient light fixtures of each space so they dim at the same rate.
  - 3) Override button(s) for each load provides the following functions:
    - a) Press and hold for dimming control (Dim Up).
    - b) Press and hold for dimming control (Dim Down).
  - 4) Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.

c. Daylight sensors:

- 1) Digital daylighting sensors shall work with load controllers and relay panels to provide automatic dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
  - a) Closed loop sensors measure the ambient light in the space and control a single lighting zone.
  - b) Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
  - c) Dual loop sensors measure both ambient and incoming daylight in the space to ensure that proper light levels are maintained as changes to reflective materials are made in a single zone.

d. Plug Load Control:

- 1) Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
- 2) Default operation is Auto-on/Auto-off, based on lighting control in space as indicated on drawings.

e. Digital LCD Switches:

- 1) Programmable control functionality including:
  - a) Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
  - b) Individual button function may be configured to Toggle, On only or Off only.
  - c) Individual scenes may be locked to prevent unauthorized change.
  - d) Ramp rate may be adjusted for each dimmer switch.
  - e) Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
  - f) Button priority may be configured to any priority level corresponding to system operation allowing local actions to utilize life safety priority.
  - g) Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.

f. Digital Partition Control:

- 1) Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.



- g. Device Status LEDs to indicate:
  - 1) Data transmission.
  - 2) Device has power.
  - 3) Status for each load.
  - 4) Configuration status.
  
- h. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
  - 1) Turn on to 100 percent.
  - 2) Turn off.
  - 3) Turn on to last level.

C. POWER REQUIREMENTS

- 1. Include 120 VAC or 277 VAC power for each controller and power supply, as required.

D. EQUIPMENT

- 1. Control Panels: Include power supply, relays, network equipment, dry contact inputs, dry contact outputs, 0-10V dimming modules pre-wired in a single NEMA 1 enclosure.
- 2. On/Off Control Relays: Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load mounted in lighting control panel.
- 3. 0-10V Dimming Controller: The 0-10 V output controller compatible with 0-10V dimming driver/ballast and mounted in lighting control panel. 0-10V output shall automatically open upon loss of power to the Controller to assure full light output from the controlled lighting.
- 4. On/Off/0-10V Dimming Control Module: On/Off and dimming to control one output or load.
  - a. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load.
  - b. Dual Voltage (120/277 VAC, 60 Hz) capable rated for 3A total load used for single light fixture control.
- 5. Phase Dimming Controllers: Forward phase 120V dimming modules with network communication functionality.
- 6. Ceiling/Wall Occupancy Sensors: Features include the following:
  - a. Finish white. Provide compatible wall plates with decorator opening.
  - b. Sensors capable of operating normally with electronic ballasts/drivers, PL lamp systems, and rated motor loads.
  - c. Detection technology: Dual Technology activation and/or re-activation.
  - d. Time delay: 1-30 minutes in 1 minute increments.
  - e. Test mode: Five second time delay.
  - f. Coverage of sensors remain constant after sensitivity control has been set. Automatic reduction shall not occur in coverage due to cycling of air conditioner or heating fans.
  - g. Sensors readily accessible with user adjustable settings for time delay and sensitivity.
  - h. Include bypass manual override on each sensor in event of failure. When bypass is utilized, lighting shall remain on constantly or control shall divert to wall switch until sensor is replaced. Control recessed to prevent tampering.

- i. Include LED as continuous visual means of indication to verify that motion is being detected during both testing and normal operation.
  - j. Include internal additional isolated relay with NORMALLY OPEN, NORMALLY CLOSED, and COMMON outputs for use with HVAC control, data logging, and other control options.
  - k. Provide additional detection devices as required for the space.
  - l. Provide sensors that can function at the same mounting height as the light fixtures.
  - m. Manufacturer: 9-10ft ceilings: Sensor Switch CM-PDT 9. High bay: Sensor Switch CMB 6.
7. Wall Switch Occupancy Sensors:
- a. Finish white. Provide compatible wall plates with decorator opening.
  - b. Capable of operating normally with electronic ballasts/drivers, PL lamp systems, and rated motor loads.
  - c. Detection technology: Dual Technology activation and/or re-activation.
  - d. Time delay: 1-30 minutes in 1 minute increments.
  - e. Test mode: Five second time delay.
  - f. Coverage of sensors remains constant after sensitivity control has been set. Automatic reduction shall not occur in coverage due to cycling of air conditioner or heating fans.
  - g. On/Off push button.
  - h. Dim up/Dim down push button with 0-10V Dimming.
  - i. Manufacturer:
8. Photo Sensors:
- a. Finish: White. Provide compatible wall plates or ceiling plates with decorator opening.
  - b. Sensor's internal photodiode shall only measure light waves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers. Sensor light level range shall be from 1-6,553 foot-candles (fc).
  - c. Open loop digital photo sensors shall include the following additional features:
    - 1) An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
    - 2) Automatically establishes application-specific set points following manual calibration using a wireless configuration tool or a PC with appropriate software. For dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
9. Digital Control Switches:
- a. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration.
  - b. Finish: White. Provide compatible wall plates with decorator opening.

10. Plug Load Control: 120 VAC, 60 Hz rated for 20A total load.
  - a. Automatic Load Control Relay: UL 20 rating for receptacle control.
    - 1) Digital relay connected to lighting control system provides ON/OFF control of plug loads within a space/zone via a programmable control relay.
11. Partition Sensors:
  - a. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors. Sensors to operate outside of the visible spectrum.
12. Network Communication Equipment: System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies. Hardware compatible with lighting controls systems that provides the following functions:
  - a. Facilitation of global network communication between different areas and control zones.
  - b. Time-based control of downstream wired and wireless network devices.
  - c. Built-in capability for future Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment, or Owner local network.
  - d. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
13. Emergency Lighting Control Equipment:
  - a. Manufacturers: Iota, Bodine, Sidelite, Acuity, Functional Devices or approved.
  - b. Equipment:
    - 1) Automatic Load Control Relay: UL 924 listed control relay.
      - a) Digital relay connected to lighting control system provides ON/OFF control of emergency lighting within a space/zone via a programmable control relay.
      - b) Relay provides ON/OFF control of emergency lighting within a space/zone by monitoring the status of the normal lighting control switch for the space/zone.
    - 2) Branch Circuit Emergency Lighting Transfer Switch: UL 1008 Listed Control Transfer Switch rated for 20 Amps.
    - 3) Features include:
      - a) 120/277 Volts, 50/60 Hz, 20 Amp ballast rating.
      - b) Push to test button.
      - c) Auxiliary contact for remote test.

- d) Programmable Test Switch (single test button for entire system may be provided where approved by local AHJ. Label switch at 'Emergency Test Button').
- e) Auxiliary contact for fire alarm system interface.
- f) Monitors a circuit providing normal lighting in the space

### 2.03 SITE EXTERIOR LIGHTING CONTROLS

- A. Site pole lighting, bollards and selected building mounted light fixtures shall be controlled through a Hubbell NX wireless control system. The wireless controls shall include astronomical timeclock, occupancy sensor, group controls and individual controls. Site light fixtures shall include wireless communication with the control system.
- B. The control system software shall be downloaded on Owner's network or dedicated PC server (as required by owner - verify) for monitoring, manual control, and programming throughout Owner's PCs.
- C. Provide all components required for site wireless controls including headend equipment, software, control devices and wireless repeaters.
- D. Site lighting fixtures shall include integral occupancy sensors interfaced with site wireless control system as indicate on drawings.
- E. Refer to drawings and schedules for general site lighting requirements. Verify detailed operating schedules and parameters including grouped controls, occupancy sensor settings and setback lighting levels with the Owner.
- F. Site exterior lighting control system will be separate from the interior lighting control system and not interfaced with the DDC system. Provide all components, line voltage and low voltage wiring systems for a complete installation.
- G. Locate NXAC2-120 NX Area Controller, NXHNB2 network bridge module, and NX Room Controller in electrical room.
- H. For exterior light fixtures, not mounted to building, provide integral NX radio module for appropriate communication with other fixtures and controller.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PRE-INSTALLATION MEETINGS

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

- B. Review installation procedures and coordination required with related Work and the following:
  - 1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
  - 2. Review the specifications for low voltage control wiring and termination.
  - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
  - 4. Review interface with Division 23 Controls including list of BACnet integration points, schedules and responsibilities.
  - 5. Discuss requirements for integration with other trades.
  
- C. Inspect and make notes of job conditions prior to installation:
  - 1. Record minutes of the conference and provide copies to all parties present.
  - 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.

### 3.03 PRE-INSTALLATION TRAINING

- A. Prior to installation, post submittal, the manufacturer shall provide an on-site training session for the contractor. This is a mandatory meeting for the installing contractor to attend and is to be scheduled by the contractor. Notify A/E two weeks prior to meeting date. Manufacturer to provide agenda and Contractor to provide meeting minutes and attendance list.

### 3.04 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
  
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.
  
- C. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

### 3.05 INSTALLATION

- A. Install system in accordance with the drawings, this section, Sections 260511, 260519, 260553, 262726, applicable codes and manufacturer's recommendations. Install wiring in compliance with NEC for power and non-power limited signaling circuits. Upon completion, certify in writing to the Owner and general contractor that system has been installed in compliance with NEC.
  
- B. Lighting Control Equipment:
  - 1. Room Controllers/Control Panels: Install where indicated on the plans. Provide power supply and circuit as indicated on the plans, if no circuit is indicated circuit with load on relay 1.
  - 2. Emergency Control Equipment: Install equipment next to normal power lighting controls for the space.

3. On/Off/O-10V Control Modules:
    - a. Remote Modules: Install remote mounted control modules in accessible location. Where possible mount to junction box connected to first light fixture in the lighting control zone.
    - b. Centrally located Control Modules: Two or more control modules mounted in a single location, install control units in a single enclosure with voltage barriers.
  4. 0-10V Dimming Controllers: Install in room controllers/control panels where possible. Mount in NEMA 1 enclosure above entry doorway into space and in an accessible location where modules are providing control.
  5. Phase Dimming Controllers: Install in electrical rooms.
  6. Ceiling/Wall Occupancy Sensors: Install where indicated on the drawings and as required to provide complete coverage based on shop drawings layouts.
    - a. Open to structure overhead sensors mount at same height as light fixtures.
  7. Wall Switches: Mounting height to match switches in Section 260519.
  8. Photo Sensors: Mount per manufacturer recommendations in locations indicated on shop drawings.
  9. Network Communication Equipment: Install in main electrical room.
- C. Test conductors for ground conditions before making final wiring connections. Comply with requirements in Section 260526.
- D. Maintain wiring color code throughout installation. Include color code identification in the Operation and Maintenance Manual.
- E. Coordinate with appropriate subcontractors for installation of equipment and devices that pertain to other work in the contract.
- F. Clean dirt and debris from inside and outside of the equipment after completion of installation.
- G. All line voltage connections shall be tagged to indicate circuit and switched legs.
- H. Test all devices to ensure proper communication.
- I. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.
- J. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
  1. Sensor parameters, time delays, sensitivities, and daylighting set points.
  2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.).
  3. Load Parameters (e.g. blink warning, etc.).
  4. Normalized dimming in lighting control system to match dimming curve of each space main ambient light fixtures.
- K. Post Start-up Tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy.

- L. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.
- M. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.
- N. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to controllers.

### 3.06 INTERIOR LIGHT LEVEL SET POINTS

- A. Light Levels: Measurements shall be made in accordance with the methods set forth in Section 9.15 of the IES handbook, 10<sup>th</sup> Edition.
  - 1. Measure all spaces/areas identified with a light level set points.
  - 2. Set dimming level of light fixtures so the maximum light output matches the light level set point.
  - 3. Photo sensors:
    - a. Daylight Zones:
      - 1) Automatic dimming of light fixtures in primary/secondary daylight zones to maintain illumination levels indicated on Contract Drawings.
      - 2) Automatically turn off light fixtures when daylight illumination exceeds maintained illumination levels.
      - 3) Light fixture shall dim to driver/ballast lowest rated light output prior to switching off.
    - b. Non-Daylight zones:
      - 1) Automatic dimming of light fixtures in control zones to maintain light level set point indicated on Contract Drawings.

### 3.07 OCCUPANCY SENSOR SETTINGS

- A. Ceiling and wall mount occupancy/vacancy sensor time delay settings of 20 minutes except spaces below or indicated otherwise in the drawings:

### 3.08 EMERGENCY LIGHTING CONTROL EQUIPMENT INSTALLATION

- A. Provide emergency lighting control equipment as required to support control requirements indicated in the Drawings.
  - 1. Install remote mounted control equipment in accessible location. Where possible mount to junction box connected to first light fixture in the lighting control zone.
  - 2. Emergency Control Equipment: Two or more controllers mounted in a single location, Install all control units in a single enclosure.

### 3.09 IDENTIFICATION

- A. Identify components, power and control wiring according to Division 26 Section "Electrical Identification".

- B. Identify controlled circuits in Directory Cards.
- C. Provide engraved nameplate to identify time switches and contactors with a unique designation.
- D. Provide engraved push buttons on digital switches, confirm switch labels with Owner.
- E. Provide printed labels on ceiling tiles or grid runners below all above ceiling mounted control devices.
- F. Provide printed labels on Control Relays and modules to indicate controlled loads.

### 3.10 CONTRACTOR COMMISSIONING

- A. Upon completion of initial contractor self-commissioning, the contractor shall coordinate system commissioning by the manufacturer's factory authorized representative who shall verify the system is complete and fully functional.
- B. Provide computer generated documentation on the commissioning of the system with room by room description including:
  - 1. Sensor parameters, time delays, sensitivities, daylighting set points.
  - 2. Sequence of operations (e.g. Manual On, Auto OFF, etc.).
  - 3. Load Parameters (e.g. blink warning, etc.).
  - 4. Re-commissioning – After 30 days from occupancy, recalibrate occupancy/vacancy sensor time delay settings, occupancy/vacancy sensor sensitivity settings and photo sensor light level settings. Provide detailed report to A/E for review.

### 3.11 COMMISSIONING SUPPORT

- A. Factory technician shall be on-site to support the enhanced commissioning process.

### 3.12 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Owner and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.
- B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
  - 1. Verify Class I and II wiring connections are terminated properly by validating system performance.
  - 2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
  - 3. Verify/complete task programming for all switches, dimmers, time clocks, and sensors.
  - 4. Verify that the control of each space complies with the Sequence of Operation.
  - 5. Correct any system issues and retest.



- C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
1. Date of test or inspection.
  2. Loads per space, or Fixture Address identification.
  3. Quantity and Type of each device installed.
  4. Reports providing each device's settings.

**3.13 DEMONSTRATION AND TRAINING**

- A. Before Substantial Completion, arrange and provide a one-day (8 hour) Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instructions includes:
1. Confirmation of entire system operation and communication to each device.
  2. Confirmation of operation of individual relays, switches, and sensors.
  3. Confirmation of system Programming, photocell settings, override settings, etc.
  4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.
- B. Provide additional one-day (8 hour) site visit for on additional training and site tuning 60-90 days after occupancy.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 22 00  
TRANSFORMERS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes dry-type transformers and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. 10 CFR 431.196.a.2, U.S. Department of Energy (DOE) Energy Conservation Standards for low-Voltage Dry-Type Distribution Transformers.
  - 2. ANSI C57.96, IEEE Guide for Loading Dry-Type Distribution and Power Transformers.
  - 3. ASTM D 635, Standard Test Method for Rate of Burning and/or Extent Time of Burning Plastics in a Horizontal Position.
  - 4. NEMA TR1, Transformers, Regulators, and Reactors.
  - 5. NFPA 70, National Electrical Code (NEC).
  - 6. UL 506, Standard for Specialty Transformers.
  - 7. UL 1561, Standard for Dry-Type General Purpose and Power Transformers.
- C. Comply with NEC as applicable to installation and construction of electrical power/distribution transformers, with applicable portions of NEMA TR 1, and with applicable ANSI/IEEE standards pertaining to power/distribution transformers.
- D. Comply with applicable portions of UL 506. Distribution transformers UL listed and labeled.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of transformer and appurtenance. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated loads, sound level, tap configurations, insulation system type, and rated temperature rise.

- C. Shop Drawings: Submit dimensioned drawings of transformer installations, showing layout, mountings and supports, and spatial relationship to proximate walls and equipment.
- D. Test Reports:
  - 1. Field test reports.
  - 2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

1.05 **STORAGE AND HANDLING**

- A. Comply with requirements in Section 260510.
- B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- C. Handle transformers using lifting eyes and brackets included for that purpose. Protect units against entrance of rain, sleet, and snow if handled in inclement weather.

PART 2 - PRODUCTS

2.01 **TRANSFORMERS**

- A. Manufacturers: Square D, Eaton/Cutler Hammer, General Electric, Siemens, Tierney, Hammond, or approved.
- B. Ratings:
  - 1. KVA and voltage ratings as shown on the Drawings.
  - 2. Transformers designed for continuous operation at rated kVA, for 24 hours a day, and 365 days a year operation with normal life expectancy as defined in ANSI C57.96.
  - 3. Transformer sound levels not to exceed the following ANSI and NEMA levels for self-cooled ratings:
    - a. Up to 9 kVA: 40 db.
    - b. 10 to 50 kVA: 45 db.
    - c. 51 to 150 kVA: 50 db.
    - d. 151 to 300 kVA: 55 db.
    - e. 301 to 500 kVA: 60 db.
    - f. 501 to 700 kVA: 62 db.
    - g. 701 to 1000 kVA: 64 db.
- C. Construction:
  - 1. Insulation Systems:
    - a. Transformers insulated with 220 C insulation system based upon 150 C rise.
    - b. Required performance obtained without exceeding above temperature rise in 40 C maximum ambient.
    - c. Insulation materials flame-retardant and not support combustion as defined in ASTM D 635.

2. Core and Coil Assemblies:

- a. Transformer core constructed with high-grade, non-aging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Maximum magnetic flux densities below saturation point. Transformer core volume shall allow efficient transformer operation at 10 percent above highest tap voltage. Core laminations tightly clamped and compressed. Coils wound of electrical grade copper with continuous wound construction.
- b. On units rated 9 kVA and smaller, core and coil assembly encapsulated in proportioned mixture of resin and aggregate for moisture proof, shock-resistant seal. Core and coil encapsulation system shall minimize sound level. Taps 2 steps below nominal voltage in 5 percent increments.
- c. On units rated 15 kVA and larger, core and coil assembly impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. Taps 2 steps above and 4 steps below nominal voltage in 2.5 percent increments.
- d. Windings and core and coil assembly treated and built to resist effects of dirt and moisture.
- e. Core coil mounted on rubber isolation mounting pads.
- f. Neutral bus sized and configured for minimum 100 percent of secondary full load current. Transformer impedance minimum of 3 and a maximum of 6 percent.

D. Enclosure:

1. Enclosure heavy gage steel. Transformers equipped with wiring compartment suitable for conduit entry and large enough to allow convenient wiring. Maximum temperature of enclosure not to exceed 90 C. Core of transformer grounded to enclosure.
2. On units rated 9 kVA and smaller, enclosure construction totally enclosed, non-ventilated, NEMA 3R, with lifting eyes.
3. On units rated 15 kVA and larger, enclosure construction ventilated, NEMA 2, drip-proof, with lifting holes. All ventilation openings protected against falling dirt.

E. Connections: Unless noted otherwise on the Drawings, 3 phase transformers with 480 Volt delta connected primary and 208Y/120 Volt, 3 phase, 4 wire connected secondary. Single phase transformers 480 Volt primary, 120/240 Volt secondary. Include provisions for external connections by means of terminal board employing lugs compatible external conductors specified in Section 260519. Connections accessible from front and top of cabinet.

F. Finish: Enclosures finished with ANSI 61 color weather-resistant enamel.

G. Accessories: On outdoor units rated 15 kVA and larger, include weather shields over ventilation openings.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.04 TRANSFORMER INSTALLATION

- A. Install transformers as indicated on the Drawings, complying with applicable NEC, NEMA, and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate transformer installation work with electrical raceway, wire, and cable work necessary for proper interface.
- C. Connect transformer units to electrical wiring system. Comply with requirements of other Division 26 sections.
- D. Grounding: Comply with requirements in Section 260526.
- E. Attach transformers to building structure to prevent overturning in event of earthquake. Include attachment nuts with washers and isolation pads. Transformers on floor, wall, or suspended from ceiling as noted on the Drawings. Bolt floor mounted transformers to concrete bases. Comply with requirements in Section 260510 for concrete bases and Section 260548 for seismic restraints. Remove shipping blocks prior to installation.
- F. Transformers with enclosures designed for floor mounting that are to be installed suspended shall include trapeze constructed of minimum 2 horizontal structural channels hung from threaded rods attached to structural members or with inserts in structural slab. Channel, rod, and inserts sized for minimum 400 percent load safety factor. Comply with requirements in Section 260548 for seismic restraints.
- G. Install transformers mounted directly on wall with rubber-in-shear isolators sized for 400 percent safety factor.

3.05 **CONNECTIONS**

- A. 208/120 Volt 3 phase secondary transformers are considered “grounded neutral separately derived systems” and shall be grounded per Section 260526.
- B. Install transformer raceway connections with flexible metal raceway. Raceways shall not enter the bottom of a transformer. Comply with requirements in Section 260533.

3.06 **FIELD QUALITY CONTROL**

- A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.
- B. Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance. If not possible, remove and provide new units and retest. Perform test in presence of Owner's Representative.
- C. Voltage Tap Connection: Connect transformers at “normal” tap. After facility is completely energized, measure secondary voltages at transformers and service switchboard. Submit list to the A/E for evaluation. Reconnect taps as directed by the A/E.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 24 10  
SERVICE ENTRANCE**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes switchboards, disconnect switches, transformers, panelboards, and associated appurtenances used for service entrance equipment as specified in applicable Division 26 sections and are included as work of this section. Extent of service entrance work is indicated on the Drawings and schedules.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.
- C. Consult local utility company relative to costs for line extensions, connections, and similar requirements and include those costs for bringing service to facility in base bid. Confirm location of point of service before bidding.
- D. Include labor and materials required to accomplish local utility company metering in accordance with power company standards and requirements.
- E. Include concrete pads of size and type required for service transformers. Verify location, size, openings, reinforcing requirements with local utility company before beginning work. Comply with local utility company clearance requirements.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Comply with NEC and NEMA standards as applicable to construction and installation of service entrance equipment and accessories. Provide service entrance equipment and accessories which are UL listed and labeled, and equipment marked, "Suitable for use as Service Equipment".

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for service entrance equipment and appurtenances.
- C. Shop Drawings: Submit dimensioned layouts of service entrance equipment and spatial relationships to proximate equipment.

- D. Test Reports:
1. Field test reports.
  2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

PART 2 - PRODUCTS

**2.01 SERVICE ENTRANCE EQUIPMENT**

- A. General: Include service entrance equipment and accessories, of type, sizes, ratings, and electrical characteristics indicated on the Drawings, which comply with manufacturer's standard materials, design, and construction in accordance with published product information, as required for complete installation, and as specified in this section.

**2.02 OVERCURRENT PROTECTIVE DEVICES**

- A. Overcurrent Protective Devices: Comply with requirements in Section 262813 and as indicated on the Drawings.
- B. Meter Sockets: Include remote meter sockets which comply with requirements of local utility company supplying electrical power to service entrance equipment of building project. Coordinate exact location of remote meter prior to bid and include costs in base bid.

**2.03 RACEWAYS, WIRES, AND CABLES**

- A. Raceways: Comply with requirements in Section 260533.
- B. Wires and Cables: Comply with requirements in Section 260519.
- C. Wall and Floor Seals: Comply with requirements in Section 260533.

**2.04 SWITCHBOARDS**

- A. Comply with requirements in Section 262413.

**2.05 DISCONNECT SWITCHES**

- A. Comply with requirements in Section 262816.

**2.06 TRANSFORMERS**

- A. Comply with requirements in Section 262200.

**2.07 PANELBOARDS**

- A. Comply with requirements in Section 262416.



PART 3 - EXECUTION

**3.01 INSPECTION**

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 SERVICE ENTRANCE EQUIPMENT INSTALLATION**

- A. Install service entrance equipment as indicated on the Drawings, in accordance with manufacturer's written instructions, and with recognized industry practices to ensure that service entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.
- B. Coordination with other work, including local utility company wiring necessary to interface installation of service entrance equipment work with other work.
- C. Install floor standing service equipment on 4 inch high concrete pad. Comply with requirements in Section 260510.

**3.05 GROUNDING**

- A. Install grounding and bonding connections for service entrance equipment and conductors. Comply with requirements in Section 260526.

**3.06 ADJUST AND CLEAN**

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.07 **FIELD QUALITY CONTROL**

- A. Upon completion of installation of service entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Repair malfunctioning units on site, then retest to demonstrate compliance. If not possible to repair on site, remove and provide new units and retest. Include copy of field test reports in the Operation and Maintenance Manual.

\*\*\*\* END OF SECTION \*\*\*\*

**SECTION 26 24 13  
SWITCHBOARDS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes free standing dead front type low-voltage service entrance, distribution and commercial metering switchboards and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards: Low voltage switchboards and components shall be designed, manufactured, and tested in accordance with the following standards:
  - 1. NEMA PB 2, Deadfront Distribution Switchboards.
  - 2. NFPA 70, National Electrical Code (NEC).
  - 3. UL 891, Standard for Dead-Front Switchboards.
- C. Manufacturer Qualifications:
  - 1. Manufacturer of assembly shall be manufacturer of circuit breakers within assembly.
  - 2. For equipment specified in this section, manufacturer shall be ISO 9000, 9001, or 9002 certified.
  - 3. Manufacturer of equipment shall have produced similar electrical equipment for minimum period of 5 years. When requested by the A/E, submit list of installations with similar equipment demonstrating compliance with this requirement.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each item and appurtenance as follows:
  - 1. Component list.
  - 2. Master nameplate schedule.
  - 3. Assembly Ratings Including:
    - a. Short circuit rating.

- b. Voltage.
    - c. Continuous current.
  - 4. Major Component Ratings Including:
    - a. Voltage.
    - b. Continuous current.
    - c. Interrupting ratings.
  - 5. Cable termination sizes and types.
- C. Shop Drawings: Submit for each item as follows:
  - 1. Front view elevation.
  - 2. Plan view.
  - 3. Top view.
  - 4. Section.
  - 5. Shipping splits.
  - 6. Assembly data.
  - 7. Wiring diagrams.
  - 8. Single line schematic diagram.
  - 9. Conduit entry/exit locations.
  - 10. Access requirements if not all front accessible.
- D. Test Reports:
  - 1. Field test reports.
  - 2. Factory test reports.
  - 3. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS:

- A. Switchboards: Square D, Eaton/Cutler Hammer, General Electric, Siemens, or approved.

### 2.02 GENERAL:

- A. Disconnecting and overcurrent protective devices as indicated on the Contract Drawings and as specified herein.
- B. Entire assembly front accessible with main lugs or main device as shown on the Drawings. Rear accessible only allowed where space is indicated on Contract Drawings.
- C. Nominal Voltage Rating: As indicated on Contract Drawings.
- D. Amperage Rating: As indicated on Contract Drawings.
- E. Short Circuit Withstand Rating: Braced to withstand short circuit rating indicated on Contract Drawings; minimum 65,000 Amps symmetrical.

- F. Short Circuit Interrupting Rating: Fully-rated for available fault current indicated on Contract Drawings. Refer to Section 262813 for additional requirements.
- G. Bus Bars: Silver-plated copper. Bus sizing based on NEMA standard temperature rise criteria of 65 C over 40 C ambient (outside enclosure).
  - 1. Horizontal Bus Bars: Fully-rated for switchboard ampacity entire length. Mounted with phases arranged in same vertical plane. Provide for future extensions from both ends.
  - 2. Neutral bus: Full capacity, unless indicated otherwise, installed entire length of switchboard.
  - 3. Ground bus: Minimum 1/4 inch by 2 inches installed entire length of switchboard and secured to each vertical section structure.
- H. Enclosure – Indoor: Steel, NEMA 1. Finish: Exterior and interior steel surfaces of switchboard cleaned and furnished with rust-inhibiting phosphatized coating. Color and finish ANSI 61 light gray. Include pullbox on top of switchboard, where indicated on Contract Drawings or where approved.
- I. Enclosure – Outdoor: Steel, NEMA 3 lockable enclosure. Finish: Exterior and interior steel surfaces of switchboard cleaned and furnished with rust-inhibiting phosphatized coating. Color and finish ANSI 61 light gray. Include pullbox on top of switchboard, where indicated on Contract Drawings or where approved.
- J. Control Accessories and Wiring: Type SIS, bundled and secured with nylon ties. Insulated locking spade terminals for control connections except where saddle type terminals are integral to device.
  - 1. Connect current transformer secondary leads to accessible short circuit terminal blocks before connecting to other devices.
  - 2. Provide terminal blocks with suitable numbering strips for groups of control wires leaving switchboard.
  - 3. Provide wire markers at each end of control wiring.
  - 4. Provide necessary fuse blocks and terminal blocks.
  - 5. Mark control components mounted within assembly, such as fuse blocks, relays, pushbuttons, switches, and similar components for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
- K. Terminations: Compression lugs suitable for copper and aluminum cable rated for 75 C. Size for conductors as indicated on the Contract Drawings.
- L. Nameplates: For each and every instrument, protective device and disconnection device for the entire assembly. Nameplates shall designate item and circuit number and frame amp size and appropriate trip rating. Submit master nameplate list indicating switchboard designation, voltage and ampere ratings, short circuit rating, manufacturer's name, general order number, and item number. Comply with requirements in Section 260553.

## 2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. General: Fusible switches or circuit breakers as indicated on Contract Drawings.
- B. Spaces for future disconnecting and overcurrent protective devices as indicated. Spaces shall include bus extensions and ancillary devices to allow for future device without additional modifications.

- C. Short circuit rating: Fully rated.
- D. Circuit breakers: Per Section 262813.
  - 1. Circuit breakers 1200 Amps and larger: Individually-mounted, fixed molded-case circuit breakers.
  - 2. Circuit breakers smaller than 1200 Amps: Group-mounted, fixed, molded-case circuit breakers.
- E. Fuses: Per Section 262813.

#### 2.04 ELECTRONIC POWER MONITORING

- A. General: Integral microprocessor-based digital power monitoring system, wiring and appurtenances.
- B. Power Monitoring at Switchboard Main: Eaton/Cutler Hammer IQ Analyzer or equivalent with local display.
- C. Power Monitoring at Feeders, where indicated: Eaton/Cutler Hammer DP-4000 or equivalent, with local display.
- D. Controls and Networking: Provide with factory-wired CTs, PTs, power supplies, control wiring and ancillary devices. Configure for Mod-Bus interface with mechanical controls system.

#### 2.05 SERVICE ENTRANCE RATED SWITCHBOARDS

- A. Service-entrance listed and labeled.
- B. Where switchboard is utility-fed, utility metering compartment fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- C. Refer to Section 262410 for additional requirements.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 SWITCHBOARD INSTALLATION**

- A. Install on concrete housekeeping pad. Anchor to structure. Comply with requirements in Section 260510 for concrete bases and Section 260548 for seismic restraints.

**3.05 FIELD QUALITY CONTROL**

- A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

**3.06 TRAINING**

- A. Comply with requirements in Section 260500.
- B. Perform training session for Owner's representative for 1 workday at jobsite location determined by the Owner.
- C. Conduct training session by a manufacturer's qualified representative. Training program shall consist of instruction on operation of assembly, circuit breakers, fused switches, meters, and major components within assembly.

\*\*\*END OF SECTION\*\*\*

**SECTION 26 24 16  
PANELBOARDS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes panelboards for lighting and appliances, distribution circuits, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. NEMA PB-1, Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
  - 2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 3. NEMA FU 1 - Low Voltage Cartridge Fuses.
  - 4. NFPA 70, National Electrical Code (NEC).
  - 5. UL 90 - Enclosed and Dead-front Switches.
  - 6. UL 248 - Low Voltage Fuses.
- C. Units UL listed and labeled. Comply with NEC as applicable to panelboards and cabinets. Comply with requirements in NEMA 1 and NEMA 250.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data:
  - 1. Submit manufacturer's technical product data, installation instructions, maintenance data, and general recommendations for each type of panelboard and appurtenance.
  - 2. Include dimensioned drawings of panelboards and enclosures showing scaled layouts of enclosures and required individual panelboard devices, including circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, accessories, and similar items.



- C. Test Reports:
1. Field test reports.
  2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

1.05 **SPARE MATERIALS**

- A. Deliver 6 keys for panelboard enclosures to the Owner.

PART 2 - PRODUCTS

2.01 **PANELBOARDS**

- A. Manufacturers: Square D, Eaton/Cutler Hammer, General Electric, Siemens, or approved.
- B. General:
1. Except as otherwise indicated on the Drawings, panelboards, enclosures and ancillary components of types, sizes, and ratings indicated. Include number of unit panelboard devices for complete installation. Include "spaces" with hardware to receive breaker or switch of size indicated. Include CU/AL rated lugs of size to accommodate conductors shown on the Drawings and specified in Section 260519.
  2. Include separate ground busbar for panels supplying isolated ground circuits.
  3. Include feed through or double lugs with amperage equal to incoming feeder amperage unless indicated larger on the Drawings.
- C. Short Circuit Interrupting Rating: Fully-rated for available fault current indicated on Contract Drawings. Refer to Section 262813 for additional requirements.
- D. Lighting and Appliance Panelboards: Dead-front safety type with switching and protective devices in quantities, ratings, types, and arrangement indicated on the Drawings. Include bolt-on thermal magnetic type branch breakers. For multiple breakers, include common trip handle. Include copper bus bars, full-sized neutral bus, ground bus, and isolated ground bus as required.
- E. Service and Power Distribution Panelboards: Dead-front safety type with switching and protective devices in quantities, ratings, types and with arrangement indicated on the Drawings. Include copper bus bars, full-sized neutral bus, and ground bus. Include fusible or circuit breaker branch and main devices indicated on the Drawings. Comply with requirements in Section 262813 for overcurrent protective devices.
- F. Panelboard Enclosures:
1. Flush or surface as indicated on the Drawings. Tight closing doors without play when latched. Where 2 cabinets are located adjacent to each other in finished areas, include matching trim of same height.
  2. Include lock for each cabinet door. Electrical distribution equipment locks common keyed.
  3. Door within door - Fasten panelboard front with machine screws. Provide continuous piano hinge on right side of outer door with door latches/locks on left side. Provide second door over dead front with continuous piano hinge on right side with door latches/locks on left side.

- 4. Factory prime coat finish for cabinets located in finished areas. Where cabinets are located in unfinished areas, standard lacquer or enamel finish, gray or blue-gray color acceptable for factory finish coat.
- G. Identification: Comply with requirements in Section 260553.

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

#### 3.04 PANELBOARD INSTALLATION

- A. Install panelboards and enclosures where indicated on the Drawings in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure products fulfill requirements.
- B. Secure in place with top of cabinet at 6'-0", unless otherwise noted on the Drawings. Top of cabinet and trim level. Anchor cabinets directly or with concealed bracing to building structure. When panels are not located in or directly on a wall, provide support frame of formed steel channel anchored to floor and ceiling structure. Interior components not installed until structure is totally enclosed. Where panels are mounted adjacent to each other, top edges at same height.
- C. Bolt floor standing distribution panelboards to concrete base. Comply with requirements in Section 260510 for concrete bases and Section 260548 for seismic restraints.

#### 3.05 CIRCUIT INDEX

- A. For each branch circuit panelboard, prepare typewritten index listing each circuit in panelboard by number with load designation. Install within a transparent protective cover inside cabinet door. Listing shall match circuit breaker arrangements, typically with odd numbers on left and even numbers on right. Room numbers used shall be final room numbers used in building as verified with the Owner and not room numbers indicated on the Drawings.

3.06 **FIELD QUALITY CONTROL**

- A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 27 26  
WIRING DEVICES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes wall switches, receptacles, device plates, box covers, and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. Federal Specification W-C-596, Electrical Power Connector, Plug, Receptacle, and Cable Outlet.
  - 2. Federal Specification W-S-896, Switch, Toggle.
  - 3. NEMA WD 1, General Color Requirements for Wiring Devices.
  - 4. NFPA 70, National Electrical Code (NEC).
  - 5. UL 498, Standard for Attachment Plugs and Receptacles.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data for each type of wiring device and appurtenance.
- C. Test Reports:
  - 1. Field test reports.
  - 2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

PART 2 - PRODUCTS

2.01 **WALL SWITCHES**

- A. Manufacturers: Leviton, Bryant Electric, Hubbell, Pass and Seymour, or approved. Leviton model numbers are listed.
- B. Finish: Grey
- C. Wall Switches for Lighting Circuits: NEMA WD 1. General use snap switch with colored toggle handle rated 20 Amps and 120/277 Volts AC. Switch with back and side wired screw type terminals. Units specification grade.
  - 1. Single-Pole Toggle Switch: Leviton Model 5621.
- D. Weatherproof: Switches mounted in a cast metal box with gasketed, weatherproof device plate.
  - 1. Custom Text.

2.02 **RECEPTACLES**

- A. Manufacturers: Leviton, Bryant Electric, Crouse Hinds, Hubbell, Pass and Seymour, or approved. Leviton model numbers are listed.
- B. Finish: White.
- C. Convenience and Straight-Blade Receptacles: NEMA WD 1. Units specification grade. Decora style. 20A minimum.
- D. Convenience Receptacle Configuration:
  - 1. Duplex Receptacle: (20A-125V NEMA 5-20R), straight blade grounding type. Leviton Model 16362.
- E. Weather Resistant Receptacles: Receptacles mounted in a cast steel box with gasketed, weatherproof device plate. Leviton GFWT2.
- F. Specific Receptacle Configuration: NEMA WD 1. Type as indicated on the Drawings, with black plastic face.
- G. GFCI Receptacles: Duplex convenience receptacle with integral ground fault circuit interrupter. Units feed-through type for downstream device protection. Leviton Model 7899.

2.03 **DEVICE PLATES**

- A. Manufacturers: Bryant Electric, Hubbell, Leviton, Pass and Seymour, or approved. Bryant Electric and Leviton model numbers are listed.
- B. Plates in Building A:
  - 1. Wall plates for interior wall-mounted locations: White.
  - 2. Wall plates for interior ceiling mounted locations: Smooth plastic, white finish.

3. Wall plates for receptacles other than NEMA 5-20R. Stainless steel with 1/4 inch specially engraved black letters which show ampere rating, voltage, and phase.
- C. Plates in Building B and site structures:
1. Wall plates for interior wall-mounted locations: Type 302 non-magnetic stainless steel.
  2. Wall plates for interior ceiling mounted locations: Type 302 non-magnetic stainless steel.
  3. Wall plates for receptacles other than NEMA 5-20R. Stainless steel with 1/4 inch specially engraved black letters which show ampere rating, voltage, and phase.
- D. Plates on Surface Mounted Boxes: Sized to fit box without extending over sides of box.
- E. Cast Metal Plates: Cast metal box. Steel plates with steel boxes and copper-free aluminum with aluminum boxes. Stainless steel screws.
- F. Raised Sheet Steel Plates: 1/2 inch high zinc or cad-plated covers with surface mounted sheet steel boxes.
- G. Weather Resistant Cover Plate:
1. While In-Use Cover: Cast metal with hinged gasketed device covers. Leviton IUM1V-GY unless otherwise noted.
  2. Not In-Use Cover: Cast metal with hinged gasketed device covers. Leviton WM1V-GY, only where noted on contract drawings.
- H. Finish of Attachment Screws: Match that of its respective device plate.

## PART 3 - EXECUTION

### 3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

**3.04 WIRING DEVICE INSTALLATION**

- A. Install wiring devices in clean electrical boxes, free from excess building materials, dirt, and debris.
- B. Install jumbo size plates for outlets in masonry walls.
- C. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- D. Install devices and wall plates flush and level.
- E. Fasten each device to outlet box at wall surface to bring receptacle flush with plate or for switch handle the proper distance through plate.

**3.05 ORIENTATION**

- A. Install switches vertical with handle operating vertically, up position "ON". Install center at 44 inches above finished floor unless noted otherwise on the Drawings.
- B. Install receptacles vertical with ground slot up centered at 18 inches above finished floor and 6 inches above counters.
- C. Install exterior receptacles vertical with ground slot up centered at 18 inches above finished grade.

**3.06 RECEPTACLE GROUNDING**

- A. Install bare bonding wire between receptacle grounding terminal and box. Plaster ear screws connecting frame to box not acceptable for grounding.

**3.07 HANDICAPPED ACCESS**

- A. Comply with requirements of Washington State Handicapped Access Code.

**3.08 FIELD QUALITY CONTROL**

- A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.
- B. Prior to energizing circuitry, test wiring devices for electrical continuity and polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.

\*\*\*\* END OF SECTION\*\*\*\*

**SECTION 262743  
ELECTRICAL VEHICLE CHARGING STATIONS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes Level 2 Electrical Vehicle Supply Equipment (EVSE) and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. EVSE equipment will be Furnished by the Owner, installed by contractor (OFCL).

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. SAE J1772
  - 2. National Electrical Code Section 625.
  - 3. UL 2202, Electrical Vehicle (EV) Charging System Equipment.
  - 4. UL 2231, Personnel Protection Systems for Electric Vehicle (EV) Supply Circuit.
  - 5. UL 2251, Plugs, Receptacles and Couplers for Electric Vehicles
  - 6. UL 2594, Electric Vehicle Supply Equipment.
  - 7. ISO 15693.

**1.04 DEFINITIONS**

- A. EV: Electric vehicle.
- B. EV Cable: The off-board cable containing the conductor(s) to connect the EV power controller to the EV that provides both power and communications during energy transfer.
- C. EV Connector: A conductive device that, when electrically coupled to an EV inlet, establishes an electrical connection to the EV for the purpose of power transfer and information exchange. This device is part of the EV coupler.
- D. EV Coupler: A mating EV inlet and connector set.
- E. EV Inlet: The device in the vehicle into which the EV connector is inserted, and a conductive connection is made for the transfer of power and communication. This device is part of the EV coupler.



- F. EVSE: Electric-Vehicle Supply Equipment. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premise wiring and the EV.

1.05 **WARRANTY**

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EVSE that fail(s) in materials or workmanship within specified warranty period.
1. Warranty Period: Three year(s) from date of Final Acceptance.

PART 2 - PRODUCTS

2.01 **MANUFACTURERS**

- A. Chargepoint:
1. Description. Level 2 EV Charging Station, CT4000 series, dual port, bollard mount, 23ft retractable cord.
  2. Model. CT4021-GW1 with power share, LED lighting and video screen.
  3. Bollard concrete mounting kit.
  4. Power management kit.
  5. Height: 6'
- B. Chargepoint:
1. Description. Level 2 EV Charging Station, CT4000 series, single port, bollard mount, 23ft retractable cord.
  2. Model. CT4011-GW1 with power share, LED lighting and video screen.
  3. Bollard concrete mounting kit.
  4. Power management kit.
  5. Height: 6'

2.02 **PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: EVSE shall withstand the effects of earthquake motions determined according to ASCE/SEI7.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Component Importance Factor: 1.5.
- B. Ambient Temperature: Minus 15 to plus 40 deg C.
- C. Altitude: Sea level to 1000 feet.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
- E. Surge Withstand: 6 kV at 3000 A.

- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- G. EV Charging Levels:
  - 1. Dual vehicles, AC Level 2 at up to 7.2 kW per vehicle.

2.03 **EVSE DESCRIPTION**

- A. Comply with NFPA 70.
- B. Comply with:
  - 1. UL 2231-1.
  - 2. UL 2594.
  - 3. SAE J1772 for SAE combo chargers.
- C. Comply with ADA-ABA Accessibility Guidelines.
- D. Metering: +/- 2% power accuracy from 2% to 100% load.
- E. Control Power: Unit shall not require separate control power input for operation.
- F. Input Power:
  - 1. Two 40A, 208V/240V, 60 Hz, single phase circuits per charger.
  - 2. Each circuit shall be independent and not-interlocked per charger.
- G. Integral GFCI.
- H. Auto-GFCI fault retry.
- I. EVSE Mounting: Pedestal mount.
- J. Enclosures:
  - a. Enclosure rating: NEMA 3R.
  - b. Lockable.
  - c. Tamper resistant.
- K. EV Cable and Connectors:
  - 1. SAE J1772 connector. Two per charger.
  - 2. Double connectors with locking holster.
  - 3. Two, 18 foot cables per charger with cable management system.
  - 4. Field-replaceable connector and cable assembly.
- L. Status Indicators:
  - 1. LEDs to indicate power, charging, charging complete, system status, faults, and service.

- M. Display Screen:
  - 1. Daylight viewable, UV-protected display with human-machine interface capability.
  - 2. Displays power, charging, charging complete, remote control, system status, faults, and service.
  
- N. Networking:
  - 1. WAN Communications: LTE Category 4.
  - 2. LAN Communications: 2.4 GHz WiFi (802.11 b/g/n).
  - 3. Capable of remote configuration and reporting.
  
- O. Software:
  - 1. Chargepoint Commercial Service Plan.
  - 2. Chargepoint Assure. 5 year extended warranty, parts and labor on site.
  - 3. Station Activation and Configuration.
  - 4. Chargepoint Station Installation and Validation.

#### 2.04 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by utilizing cushioning materials or foam or by applying a strippable, temporary protective covering before shipping.
  
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  
- B. Examine roughing-in for EVSE electrical conduit to verify actual locations of conduit connections before equipment installation.
  
- C. Examine pavement for suitable conditions where EVSE will be installed.
  
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

- A. Comply with NECA 1 and NECA 413.

- B. Concrete Base Mounting:
1. Install EVSE on 6-inch (150-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
    - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
    - b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - d. Install anchor bolts to elevations required for proper attachment to supported equipment.
    - e. Secure EVSE to concrete base according to manufacturer's written instructions.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Vibration Isolation and Seismic Controls for Electrical Systems."
- D. Wiring Method: Install cables in below grade concealed raceways.
  1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
  2. Comply with requirements for underground raceways and enclosures specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems."
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Disconnect: Install disconnect in a readily accessible location according to Section 262816 "Enclosed Switches and Circuit Breakers."
- G. Circuit Breakers: Comply with Section 262816 "Enclosed Switches and Circuit Breakers."
- H. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking from enclosures and components.
- I. Secure covers to enclosure.

### 3.03 CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Comply with grounding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

- D. 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-486B.
- E. Verify that all electrical connections have been made according to the manufacturer's instructions. Remove all burrs, shavings, and detritus from inside the enclosure.
- F. After confirming all connections, install covers and tighten fasteners to according to manufacturer's instructions.

**3.04 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

**3.05 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. For each unit of EVSE, perform the following tests and inspections:
    - a. Unit self-test.
    - b. Operation test with load bank or with EV. *[Owner to Confirm]*
    - c. Network communications test.
- D. Prepare test and inspection reports.

**3.06 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

**3.07 SOFTWARE SERVICE AGREEMENT**

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

**3.08 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner maintenance personnel to adjust, operate, and maintain EV charging equipment.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 28 13  
OVERCURRENT PROTECTIVE DEVICES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes overcurrent protective devices for operation at 600 Volts and below, including circuit breakers and fuses as individual components in separate enclosures and for installation as integral components of switchboards and panelboards and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards: NFPA 70, National Electrical Code (NEC).
- C. Comply with NEMA and ANSI standards as applicable to construction and installation of overcurrent protective devices.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.
- C. Shop Drawings: Include layouts of circuit breakers with spatial relationships to proximate equipment.
- D. Closeout Submittals:
  - 1. Written confirmation that all circuit breaker settings were adjusted to match the power studies final report.
- E. Test Reports:
  - 1. Field test reports.
  - 2. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

1.05 **EXTRA MATERIALS**

- A. Fuses: For each type and rating, furnish additional fuses amounting to 1 unit for every 5 units installed, but not less than 2 units of each size and type.
- B. Spare Fuse Cabinet: Provide one, sized to house spare fuses provided under this contract plus 25% additional space for future.
- C. Electronic Trip Unit Test Set: Furnish one set, including associated software, capable of testing each circuit breaker type.

PART 2 - PRODUCTS

2.01 **MANUFACTURER**

- A. Circuit Breakers: Square D, Eaton/Cutler Hammer, General Electric, Siemens or approved. Circuit breaker manufacturer shall be same as panelboard and switchboard manufacturer when installed therein.
- B. Fusible Circuit Breakers: Bussmann Mfg. Co.
- C. Fuses: Bussmann Mfg. Co. or Mersen Electrical Power. No substitutions. Fuses shall be by one manufacturer.

2.02 **CIRCUIT BREAKERS**

- A. General:
  - 1. UL 489 fixed mounted molded case type with unless indicated otherwise.
  - 2. Overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication.
  - 3. Common trip for two and three pole circuit breakers. Handle ties, manufactured by circuit breaker manufacturer, permitted for multi-wire branch circuits on approval of samples.
  - 4. Trip ratings imprinted on handle or visible through deadfront cover.
  - 5. Constructed for mounting and operating in any physical position and calibrated for operation in ambient temperature up to 40 C.
  - 6. Mechanical screw type removable connector lugs, AL/CU rated, to accommodate conductors specified. Rated for 75 C conductors for 60 Amp and larger circuit breakers.
  - 7. Amperage and Voltage as indicated.
  - 8. Short circuit rating: RMS interrupting rating as indicated. Minimum 10,000 AIC rating at 120, 208 and 240 Volts. Minimum 14,000 AIC rating at 277 and 480 Volts.
  - 9. Ground Fault Interrupter (GFI) circuit breakers: Equipped with integral ground fault interrupter set to trip on ground fault of thirty milliamps or greater.
  - 10. Ground Fault Circuit Interrupter (GFCI) circuit breakers: Equipped with integral Class A ground fault circuit interrupter set to trip on ground fault of six milliamps or greater.
  - 11. Arc Fault Circuit Interrupter (AFCI) where indicated.
  - 12. Switching rated for 120 Volt and 277 Volt lighting branch circuits.
  - 13. HACR rating where serving air conditioning and refrigeration equipment.
  - 14. Current limiting, utilizing non-fuse type current limiting, where indicated.
  - 15. Tandem-mounted circuit breakers not acceptable.

16. Minimum Frame Size: To match trip rating, unless indicated otherwise.
17. Keyed Interlocks: Externally-mounted and arranged to prohibit interlocked circuit breaker operation, except in a specified sequence. Include mountings and hardware. Provide nameplates at each keyed interlock indicating interlocked circuit breaker and sequence of operation.
18. Zone-Selective Interlocking: Integral with ground fault trip unit for interlocking ground fault protection function.
19. Arc Energy Reduction: Provide energy-reducing maintenance switch with local status indicator for use as a temporary arc-flash incident energy-reduction device during maintenance activities. Provide for each circuit breaker with a frame size 1000 Amps and larger and as indicated on drawings.
  - a. Provide a manual switch on the compartment door to switch the circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce the danger from potential arc-flash at downstream equipment.
  - b. Provide a lock feature for the switch so that it may be locked in either the off or on maintenance-mode position.
  - c. Provide a blue LED indicating light to indicate that the switch is in maintenance mode.
  - d. Provide dry relay contacts on each switch for annunciation of the switch position.

## 2.03 TRIP UNITS

### A. General:

1. Thermal magnetic unless indicated otherwise.
  2. Electronic Trip Unit: Required for circuit breakers:
    - a. Sized 400 Amps and larger on 480 Volt systems.
    - b. Sized 800 Amps and larger on systems 250 Volts and lower.
    - c. Sized 100 Amps and larger serving emergency and legally-required standby systems and equipment.
    - d. Power circuit breakers.
    - e. Insulated case circuit breakers.
    - f. Where indicated or specified.
    - g. Where required by the Selective Coordination Study.
- B. Thermal Magnetic Trip Unit: Adjustable magnetic trip setting for sizes 250 Amps and larger.
- C. Electronic Trip Unit: Field-replaceable rating plug. RMS sensing Microprocessor-based, programmable, time-current shaping adjustments; complete with current transformers and sensors and the following features:
1. Programmable functions independent of each other in both action and adjustment.
  2. Adjustable settings:
    - a. Instantaneous trip; long and short-time time adjustments; long and short-time pickup adjustments.
    - b. Where ground fault protection indicated, ground fault pickup level, time delay and I<sup>2</sup>t response.
    - c. Built-in test points for testing the long time, short time, delay, instantaneous, and ground fault functions of the circuit breaker.



3. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

#### 2.04 FUSES

##### A. General:

1. Fuses of type, sizes, ratings, and electrical characteristics of single manufacturer.
2. Fuses labeled UL Class L, UL Class R, current limiting, rated for up to 200,000 Amps.

##### B. Where fuses are shown on the Drawings feeding individual or groups of equipment items, comply with manufacturer's recommendation for fusing. Adjust fuse size and type to comply with manufacturer's recommendation.

##### C. Main Service, Feeder and Branch Circuit Fuses:

1. For fuse ratings over 600 Amps: UL Class L (KRP-C or A4BY).
2. For fuse ratings up to 600 Amps: UL Class RK1 (KTN-R, KTS-R or A2K-R, A6K-R).
3. Feeder or branch circuit directly feeding motors, transformers, and other inductive load: UL RK5 time delay (FRN-R, FRS-R or TR-R or TRS-R).
4. Other Branch Circuits: UL Class RK1, (KTN-R, KTS-R or A2K-R, A6K-R).

### PART 3 - EXECUTION

#### 3.01 INSPECTION

- ##### A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

#### 3.02 PREPARATION

- ##### A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- ##### B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

#### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- ##### A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

#### 3.04 CIRCUIT BREAKERS

- ##### A. Install in panelboards, switchboards and enclosures, in accordance with the manufacturer's recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards.
- ##### B. Install handle ties for multiwire branch circuits per Section 260519.

- C. Device Settings: Adjust in accordance with the Electrical Power Studies report from Section 260573, including but not limited to the following:
  - 1. Circuit Breakers.
  - 2. Zone selective interlocking.

3.05 **FUSES**

- A. Install fuses in switches, panelboards, switchboards and enclosures. Install fuses so current rating is visible from front when cover is open.
- B. Do not install until equipment is ready to be energized.
- C. Coordinate with equipment furnished by others for proper fuse type and size.
- D. For motor and equipment circuits, fuse sizes shown on the Contract Drawings are for general guidance only. Size fuses in accordance with fuse manufacturer's recommendation for given motor nameplate ampere rating. Test operation. If nuisance tripping occurs, increase fuse size and disconnect device (if necessary) for nuisance free tripping. Adjust fuse size for ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times.

3.06 **FIELD QUALITY CONTROL**

- A. Test circuit breakers as specified in Section 260810.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 28 16**  
**DISCONNECT SWITCHES AND ENCLOSED CIRCUIT BREAKERS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes disconnect switches, elevator power modules, enclosed circuit breakers and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. NFPA 70, National Electrical Code (NEC).
  - 2. UL 98, Enclosed and Dead-Front Switches.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of equipment and appurtenance. Include equipment characteristics such as ratings, enclosure type, dimensions and weight.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURER**

- A. Disconnect Switches and Enclosed Circuit Breakers: Square D, Eaton/Cutler Hammer, General Electric, Siemens, or approved.
- B. Elevator Power Module shall be Eaton/Bussmann Quik-Spec Power Module Switch type PS with Low-Peak Class J fuses, Mersen Fusible Shunt Trip Switch – ES with Mersen AJT fuses, or approved.

**2.02 GENERAL**

- A. Ratings: Voltage, Amperage and horsepower rating suitable for circuit and equipment controlled. Service entrance rated where indicated or required.
- B. Enclosures: Surface-mounted.
  - 1. NEMA Type 1, in general.
  - 2. NEMA Type 3R where exposed to moisture and where shown on the Drawings.
- C. Accessories:
  - 1. Padlockable in "OFF" position.
  - 2. Labeled "ON"/"OFF" position.
  - 3. Ground lug.
  - 4. Neutral lug where applicable.
  - 5. Other accessories as indicated.
- D. Nameplates: Per Section 260553.

**2.03 DISCONNECT SWITCHES**

- A. General: Heavy duty, UL 98, horsepower rated with external handle.
- B. Interlock: Defeatable door interlock that prevent door from opening when operating handle is in "ON" position.
- C. Fusible or non-fusible as indicated. Fuse rejection clips where Class R fuses are specified.
- D. Quick-make, quick-break mechanism. Visible blades.

**2.04 ELEVATOR POWER MODULE RATINGS AND CONSTRUCTION**

- A. Shunt-trip fused disconnect must be listed to UL 98 with integral control wiring for elevator circuits.
- B. Shunt-trip fused disconnect switch with all necessary relay(s), control transformer and other options, as shown on drawings and listed below:
  - 1. Ampere rating of the switch shall be based upon the elevator manufacturer requirements for listed fuses.
  - 2. Interlocks to prevent the opening of the cover when the switch is in the ON position. Interlock shall be defeatable for testing purposes.
  - 3. Handle lockable in OFF position.
  - 4. Provide accessories per below:
    - a. 100VA control power transformer with primary and secondary fuses. Primary voltage same as elevator voltage. Secondary voltage 120V.
    - b. 120V AC Isolation relay (3PDT, 10 Amp, 120V).
    - c. Key to Test Switch.
    - d. Green "On" Pilot Light.
    - e. 2P NC Mechanical Interlock.
    - f. Fire Alarm Voltage Monitoring Relay.
    - g. NEMA 1 Enclosure.

5. Entire assembly (including shunt-trip switch, control wiring and accessories) shall have a short-circuit rating of 200,000A.
6. Complete catalog number for the Power Module Switch shall be Eaton/ Bussmann PSXTXXR1KGBF3 or Mersen ESXTXXR1KGB

**2.05 ENCLOSED CIRCUIT BREAKERS**

- A. Circuit Breaker: Thermal magnetic circuit breaker per Section 262813. One form "C" auxiliary contact activated when circuit breaker open.
- B. Short Circuit Interrupting Rating: Fully-rated for available fault current indicated on drawings.

**PART 3 - EXECUTION**

**3.01 INSPECTION**

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

**3.02 PREPARATION**

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

**3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE**

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Comply with applicable requirements of NEC, NEMA and NECA standards, and with recognized industry practice. Where these may be in conflict, the more stringent requirements govern.
- B. Install where indicated on the Contract Drawings and where required. Mount independent of equipment served; do not attach to equipment served.
- C. Coordinate installation work with electrical raceway, wire, and cable work as necessary for proper interface. Comply with requirements in Section 260533.
- D. Install within sight of equipment or controller served.
- E. Where locations are not shown on Contract Drawings, locate on wall adjacent to equipment being served or on formed steel channel frame at face of equipment. Coordinate location to maintain equipment clearances.
- F. Elevator Power Module main line disconnecting means shall be located in compliance with the following:
  1. Inside the machine room door on the lock jamb side of the machine room door.
  2. Not more than twenty-four inches from the jamb to the operating handle.

3. Not less than thirty-six inches and not more than sixty-six inches above the finished floor as measured to the centerline to the disconnect handle.

3.04 **FIELD QUALITY CONTROL**

- A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.
- B. Elevator Power Module: Test shunt-trip upon activation of fire alarm device(s). Test reset operation and system test functionality. Coordinate testing with fire alarm and elevator system contractors.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 32 13  
PACKAGED ENGINE GENERATOR**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes packaged diesel engine-generator sets for standby power with unit mounted cooling system, unit mounted control and monitoring, outdoor enclosure and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, and Sections 26 05 00 and 26 05 10 apply to work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
  - 2. ASME B15.1, Safety Standard for Mechanical Power Transmission Apparatus.
  - 3. NEMA AB1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
  - 4. NEMA ICS 6, Industrial Controls and System Enclosures.
  - 5. NEMA MG-1, Motors and Generators.
  - 6. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 7. NFPA 30, Flammable and Combustible Liquids Code.
  - 8. NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
  - 9. NFPA 70, National Electrical Code (NEC)
- C. Manufacturer and/or Supplier Qualifications:
  - 1. Minimum of 5 years in business of distributing and installing and maintaining specific type of generation equipment under present firm name.
  - 2. Capable of dispatching maintenance and repair truck with qualified factory trained repairman and spare parts to the job site within 1 hour of request for service on equipment.
  - 3. Equipment manufacturer with minimum of 5 years' experience to regularly assembled and manufactured such equipment.
  - 4. Supplier with local office within 75 miles of project site, with factory trained representatives employed for minimum of 1 year.

5. Supplier shall maintain spare parts stock to minimize down time in case of equipment failure.
  6. Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those included for this Project. Comply with requirements in Section 26 05 29.
- D. Testing Agency Qualifications: Independent agency with experience and capability to conduct testing, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and acceptable to the AHJs.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Article "Field Quality Control."
- E. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to the AHJ and marked for intended use.
- G. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- H. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

#### 1.04 COMMISSIONING

- A. Equipment and systems referenced in this section shall be commissioned. Contractor has specific responsibilities for scheduling, coordination, test development, testing and documentation. Coordinate commissioning activities with the Commissioning Authority.

#### 1.05 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 26 05 00.
- B. Product Data: Submit manufacturer's technical product data and for each component and appurtenance. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include the following:
1. Thermal damage curve for generator.
  2. Time current characteristic curves for generator protective device.
  3. Generator operation chart with leading, lagging power factor as a function of kW and kVA load.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include the following:
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.



2. Design Calculations: Signed and sealed by a qualified Professional Engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights. Comply with requirements in Section 26 05 48.
  3. Provide fuel consumption chart from no load to 100% rated load.
  4. Wiring Diagrams: Power, signal, and control wiring.
  5. Provide list of all generator monitoring, control and alarm points. Provide recommendation of required alarm and monitoring points and interconnection for remote monitoring through Owner's BMS.
  6. Dimensioned plan showing all clearances required for code compliance, airflow, and maintenance. Include dimension block out location for conduit stub-ups in concrete foundation.
- D. Certification: Manufacturer seismic qualification certification that fuel tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces. Comply with requirements in Section 26 05 48.
1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Test Reports:
1. Factory start-up and test reports.
  2. Field start-up and test reports.

#### 1.06 OPERATION AND MAINTENANCE MANUALS

- A. Comply with requirements in Division 01 and Section 26 05 00.
- B. Include step by step instructions for startup and shutdown.
- C. Include copies of test forms, service forms, and maintenance data, including test and servicing intervals, fluid levels, lubrication requirements, filters, antifreeze, and recommended lubricants.

#### 1.07 WARRANTY

- A. Packaged Engine Generator: Two years from date of final completion.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Packaged Engine Generator: Preferred manufacturer is Cummins. Base pricing on Cummins with alternate pricing for Kohler and Caterpillar.

#### 2.02 ENGINE-GENERATOR SET

- A. Factory assembled and tested, engine generator set.

- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation. Include lifting attachments.
- C. Capacities and Characteristics:
  - 1. Power Output Ratings: Refer to drawings.
  - 2. Output Connections: Three-phase, four wire.
  - 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator Set Performance:
  - 1. Steady State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
  - 2. Transient Voltage Performance: Maximum 20 percent variation for 50 percent step load increase or decrease. Voltage shall recover and remain within steady state operating band within 3 seconds.
  - 3. Steady State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  - 4. Steady State Frequency Stability: No random speed variations outside steady state operational band and no hunting or surging of speed when system is operating at any constant load within the rated load.
  - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step load increase or decrease. Frequency shall recover and remain within steady state operating band within 5 seconds.
  - 6. Output Waveform: At no load, harmonic content measured line-to-line and line-to-neutral not to exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, not to exceed 50 percent.
  - 7. Sustained Short Circuit Current: For 3-phase, bolted short circuit at system output terminals, system shall supply minimum 250 percent of rated full load current for not less than 10 seconds and then clear fault automatically without damage to generator system components.
  - 8. Start Time: Comply with requirements in NFPA 110 for Type 10 system requirements.
- E. Branch Circuit Panelboard:
  - 1. Provide integral branch circuit panelboard pre-installed within generator set for powering all 120/208 VAC loads within generator set.
  - 2. 120/208 VAC, single-phase panelboard rated at 100A, minimum.

## 2.03 ENGINE

- A. Fuel: Fuel oil, Grade DF-2.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.
- D. Lubrication System: Include the following items mounted on engine or skid:
  - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit capable of full flow and designed to be fail safe.
  3. Crankcase Drain: Arranged for complete gravity drainage to removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine to ensure adequate primary fuel flow under starting and load conditions.
  2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with requirements in NFPA 110 for Level 1 equipment for heater capacity.
- G. Governor: Control engine speed within plus or minus 3 Hz at 60 Hz (speed regulation 5 percent) from no load to full load generator output. Maintain steady state frequency at any constant load, including no load, within band of plus or minus 0.25 Hz rated frequency. Governor not to permit frequency modulation, defined as number of times per second that frequency varies from average frequency in cyclic manner, in excess 1 Hz per second.
- H. Cooling System: Closed loop, liquid cooled with radiator factory mounted on engine generator set mounting frame, engine driven fan, and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene glycol based antifreeze and 50 percent water with anticorrosion additives as recommended by engine manufacturer.
  2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed loop coolant system pressure for engine used. Include gage glass and petcock.
  4. Temperature Control: Self-contained, thermostatic control valve that modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging, ultraviolet, and abrasion resistant fabric.
    - a. Rating: 50 psig maximum working pressure with coolant at 180 F and non-collapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system not to exceed engine manufacturer's engine backpressure requirements.
1. Sound Attenuation: Minimum 25 dB at 500 Hz.
  2. Maximum 85 dBA sound level measured at distance of 10 feet from exhaust discharge.
  3. Comply with local jurisdictional requirements if more stringent.
- J. Engine Exhaust Flexible Connectors: Sized to match engine exhaust outlet connection and as recommended by engine manufacturer.

- K. Air-Intake Filter: Heavy duty, engine mounted air cleaner with replaceable dry filter element and "blocked filter" indicator.
- L. Starting System:
1. Components: Sized not to be damaged during full engine cranking cycle at maximum ambient temperature.
  2. Cranking Motor: Heavy duty unit that automatically engages and releases from engine flywheel without binding.
  3. Cranking Cycle: Minimum 60 seconds.
  4. Redundant Battery System: Provide two separate battery systems and chargers configured for redundant operation.
  5. Battery: Capacity within ambient temperature range for specified cranking cycle at least twice without recharging. Include 120 Volt battery heater.
  6. Battery Cable: Size as recommended by engine manufacturer. Include required interconnecting conductors and connection accessories.
  7. Battery Charging Alternator: Factory mounted on engine with solid state voltage regulation and 35-A minimum continuous rating.
  8. Battery Charger: Current limiting, automatic equalizing and float charging type. Comply with UL 1236. Include the following features:
    - a. Operation: Equalizing charging rate of 10 Amps initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 C to plus 60 C to prevent overcharging at high temperatures and undercharging at low temperatures.
    - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    - d. Ammeter and Voltmeter: Flush mounted in door to indicate charging rates.
    - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition shall close contacts that provide a battery charger malfunction indication at system control and monitoring panel.
    - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

#### 2.04 FUEL OIL STORAGE

- A. Comply with requirements in NFPA 30.
- B. Base Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Include the following features:
1. Tank level indicator.
  2. Capacity: As required to provide 48 hour of run time at full load capacity.
  3. Vandal resistant fill cap/spill 5 gallon capacity.
  4. Containment Provisions: Comply with requirements of the AHJs.
  5. Low level alarm sensor.
  6. Secondary containment leak alarm sensor.
  7. High level alarm sensor.

8. Standard 2" vent shall be extended 12 feet above grade.
9. Events for fuel tank and rupture basing shall terminate outside enclosure.

## 2.05 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode selector switch on control and monitoring panel is in "AUTO" position, remote control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode selector switch is switched to "ON" position, generator set starts. "OFF" position of same switch initiates generator set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of remote emergency stop switch also shuts down generator set.
- B. Include the Following Indicating and Protective Devices and Controls:
  1. AC voltmeter.
  2. AC ammeter.
  3. AC frequency meter.
  4. DC voltmeter (alternator battery charging).
  5. Engine coolant temperature gage.
  6. Engine lubricating oil pressure gage.
  7. Running time meter.
  8. Ammeter and voltmeter and phase-selector switch(es).
  9. Generator voltage adjusting rheostat.
  10. Start/stop switch.
  11. Overspeed shutdown device.
  12. Coolant high temperature shutdown device.
  13. Coolant low level shutdown device.
  14. Oil low pressure shutdown device.
  15. Fuel tank low level alarm.
  16. Fuel tank high level shutdown of fuel supply alarm.
  17. Fuel tank leak alarm.
  18. Generator overload.
- C. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator.
- D. Alarm Contacts: Include separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication for connections for data link transmission of indications to remote data terminals.
- E. Remote Alarm Annunciator: Comply with NFPA 99. LED labeled with respective alarm conditions shall identify each alarm event and common audible signal shall sound for each alarm condition. Silencing switch on face of panel shall silence signal without altering visual indication. Connect so that after alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate flush mounting type to suit mounting conditions. Provide remote annunciator at the building electrical room.
- F. Load Bank: Provide generator circuit breaker and Cam Lock enclosure for portable load bank testing.
- G. All generator control, operation and alarm conditions shall be interfaced with the building management system. Provide BACnet communication protocol.

**2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION**

- A. Generator Circuit Breaker: Molded-case, electronic-trip type, 100 percent rated. UL 489.
  - 1. Tripping Characteristics: Adjustable long time and short time delay and instantaneous.
  - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
  - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
  - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Ground Fault Indication: Comply with requirements in NFPA 70 for emergency system signals for ground fault. Integrate ground fault alarm indication with other generator set alarm indications.

**2.07 GENERATOR, EXCITER, AND VOLTAGE REGULATOR**

- A. Comply with requirements in NEMA MG 1.
- B. Drive: Generator shaft directly connected to engine shaft. Exciter rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F. Design shall be 105 deg C temperature rise based on continuous operation.
- D. Stator Winding Leads: Terminate at terminal box to permit future reconnection for other voltages.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip-proof.
- G. Voltage Regulator: Solid state type, separate from exciter, for performance specified in this section. Include adjustable control at operating panel for plus or minus 5 percent of output-voltage operating band.
- H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- I. Generator Pitch: 2/3 stator winding.

**2.08 OUTDOOR GENERATOR SET ENCLOSURE**

- A. Description: Weatherproof sound attenuated, Level 2, steel enclosure. Multiple hinged, lockable panels with adequate access to components requiring maintenance. Panels removable by one person without tools. Instruments and control mounted within enclosure.
- B. Sound attenuated enclosure shall limit sound level to 75 dBA maximum measured 7 meters from generator. Comply with local jurisdiction requirements, minimum.

- C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed engine, cooling air inlet and discharge. Storm proof and drainable louvers to prevent entry of rain and snow.
  2. Automatic Dampers: At engine cooling air inlet and discharge. Dampers closed when unit is not operating.
  3. Cooling air discharge shall be located at each end of the unit. Provide flanged discharge for direct connection to screen at wall. Coordinate exact dimensions with screen wall installer.

## 2.09 VIBRATION ISOLATION DEVICES

- A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical limit stops to prevent spring extension due to wind loads or if weight is removed. Include factory drilled baseplate bonded to 1/4 inch thick elastomeric isolator pad attached to baseplate underside. Include adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
  3. Minimum Additional Travel: 50 percent of required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion resistant pretreatment and compatible primer. Color as selected by the A/E.

## 2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
- B. Project Specific Equipment Tests: Before shipment, factory test engine generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  2. Full load run.
  3. Maximum power.
  4. Voltage regulation.
  5. Transient and steady-state governing.
  6. Single-step load pickup.
  7. Safety shutdown.
  8. Sound generation.
  9. Provide 14 days' advance notice of tests and opportunity for observation of tests by the Owner's representative.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Install packaged engine generator to provide access without removing connections or accessories, for periodic maintenance.
- D. Install packaged engine generator with restrained spring isolators having 1 inch minimum deflection on 4 inch high concrete base. Secure sets to anchor bolts installed in concrete bases. Comply with requirements in Section 26 05 10 for concrete bases and Section 26 05 48 for seismic restraints.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.04 CONNECTIONS

- A. Connect fuel, cooling system, and exhaust system piping adjacent to packaged engine generator to allow service and maintenance.
- B. Ground equipment according to Section 26 05 26.
- C. Connect wiring according to Section 26 05 19.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Comply with requirements in Section 26 08 00.



2. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified in this section including, but not limited to, single step full load pickup test.
  4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages for the following.
    - a. Measure charging voltage and voltages between available battery terminals for full charging and float charging conditions. Check electrolyte level and specific gravity under both conditions.
    - b. Test for contact integrity of connectors. Perform integrity load test and capacity load test for battery.
    - c. Verify acceptance of charge for each element of battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  5. Battery Charger Tests: Verify specified rates of charge for both equalizing and float charging conditions.
  6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  7. Voltage and Frequency Transient Stability Tests: Measure voltage and frequency transients for 50 and 100 percent step load increases and decreases and verify that performance is as specified.
  8. Harmonic Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- C. Provide generator testing per Section 26 08 00.
- D. Coordinate tests with transfer switches and load bank.
- E. Test instruments shall have been calibrated within last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: Provide factory fuel system leak tests.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove malfunctioning units and provide new. Retest as specified above.
- J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach label or tag to each tested component indicating satisfactory completion of tests.

- L. Provide full load test utilizing portable test bank as required by NFPA 110. Record generator output power, voltage and current characteristics. Monitor all generator system variables per generator manufacturer recommendations and NFPA 110. Simulate power failure including operation of transfer switches, and return to normal.
- M. Test generator under building load through transfer switches with UPS systems in operation as follows:
  - 1. Test generator with UPS-A on line in double conversion mode with temporary UPS output load of 60kW. Provide load bank.
  - 2. Provide load bank connected to generator distribution board totaling 80kW in addition to UPS-A load.
  - 3. Record generator output power, voltage, amperage, power factor and frequency during all tests.
  - 4. Provide simulated power loss and test generator and automatic transfer switches for proper operation. Test/operate generator for one hour.
  - 5. While under generator power transfer UPS to bypass mode and operate for 30 minutes.
  - 6. Disconnect UPS output loads. With UPS on line in double conversion mode connect th 60kW step load to UPS output. Operate on generator power for 30 minutes.
- N. Infrared Scanning: Perform infrared scan of each power wiring termination and each bus connection. Remove access panels so terminations and connections are accessible to portable scanner. Provide load banks to provide loads at 75% of overcurrent device ratings.
  - 1. Instrument: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 2. Record of Infrared Scanning: Prepare certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- O. Include copy of test reports in the Operation and Maintenance Manual.
- P. Provide all diesel fuel throughout duration of testing.

### 3.06 DEMONSTRATION

- A. Demonstrate proper system operation to the A/E and Owner utilizing factory-trained field service personnel.

### 3.07 TRAINING

- A. Conduct one training session for Owner's representatives at project site. Include training on installed equipment, system operation, emergency procedures, and maintenance. Training conducted by factory-trained service personnel. Training session shall be one 4 hour session, minimum.

### 3.08 FUEL FILL

- A. Fully fill fuel tank after tests and demonstrations have been completed.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 36 00  
TRANSFER SWITCHES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes automatic transfer switches, automatic programmed transition transfer switches, bypass/isolation switches and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. IEEE C62.41, Surge Voltages in Low-Voltage AC Power Circuits.
  - 2. NEMA ICS 1, Industrial Control & Systems General Requirements.
  - 3. NEMA ICS 6, Industrial Control and System Enclosures.
  - 4. NETA ATS, NETA Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
  - 5. NFPA 70, National Electrical Code (NEC).
  - 6. NFPA 99, Standard for Healthcare Facilities.
  - 7. NFPA 110, Standard for Emergency and Standby Power Systems.
  - 8. UL 486A and 486B, Wire Connectors.
  - 9. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
  - 10. UL 508, Standard for Industrial Control Equipment.
  - 11. UL 869A, Reference Standard for Service Equipment.
  - 12. UL 1008, Standard for Transfer Switch Equipment, unless requirements of this section are stricter.
- C. Manufacturer and Supplier Qualifications:
  - 1. In business of distributing and installing and maintaining specific type of equipment under present firm name for minimum of 5 years.
  - 2. Capable of dispatching qualified factory trained repairman and spare parts to job site within 2 hours of request for service on equipment.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, for emergency service under UL 1008, by testing agency acceptable to AHJ, and marked for intended use.

**1.04 SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 26 05 00.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of transfer switch and appurtenance. Include accessories, dimensioned shop drawings, and wiring diagrams specific to project. Wiring diagrams shall include block diagram depicting control wiring scheme and point to point interconnections.
- C. Test Reports:
  - 1. Factory test reports.
  - 2. Field test reports.
  - 3. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

**1.05 WARRANTY**

- A. General: Warrant transfer switches for 1 year after acceptable on site start up and testing. Warranty shall cover parts, labor, and travel time for the entire system. Make available replacement within 48 hours of initial notification.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Transfer Switches: Cummins Power Generation as supplied by Cummins Northwest, Kohler Co. as supplied by EC Power Systems, ASCO, GE Zenith Controls, Russelectric, or approved.

**2.02 GENERAL TRANSFER SWITCH PRODUCT REQUIREMENTS**

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations under fault conditions indicated on drawings based on testing according to UL 1008.
- C. Solid-State Controls: Repetitive accuracy of settings is plus or minus 2 percent or better over operating temperature range of minus 20 to plus 70 C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Neutral Terminals: Fully rated.
- F. Enclosures: General-purpose NEMA 250, Type 1 complying with NEMA ICS 6 and UL 508.
- G. Electrical Operation: Accomplish by non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

- H. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  - 1. Limitation: Switches using molded-case switches, circuit breakers, or insulated-case circuit-breaker components not acceptable.
  - 2. Switch Action: Double throw. Mechanically held in both directions.
  - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer switch units, rated 225 Amp and higher, with separate arcing contacts.

#### 2.03 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment requirements according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning.
- C. Manual Switch Operation: Under load with door closed and with either or both sources energized. Transfer time same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-Before-Transfer Contacts: Include set of normally open/normally closed dry contacts to operate in advance of retransfer to normal source. Interval adjustable from 1 to 30 seconds.
- E. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide midpoint between 2 working switch positions with an intentional, time-controlled pause at midpoint during transfer. Pause adjustable from minimum 0.5 to 30 seconds and factory set for 0.5 seconds. Time delay occurs for both transfer directions. Pause disabled unless both sources are live.
- F. Transfer switches shall be four pole. Switching of three 3 phase and neutral conductors.

#### 2.04 AUTOMATIC TRANSFER SWITCH FEATURES

- A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage adjustable from 85 to 100 percent of nominal. Dropout voltage adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
- B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from 0 to 6 seconds. Factory set for 1 second.
- C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator. Pickup voltage adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
- D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes. Factory set for 10 minutes. Include automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source if normal supply has been restored.
- E. Test Switch: Simulates normal-source failure.
- F. Switch-Position Pilot Lights: Indicate source to which load is connected.

- G. Source-Available Indicating Lights: Supervise sources via transfer switch normal- and emergency-source sensing circuits.
  - 1. Normal Power Supervision: Green light with nameplate engraved "NORMAL SOURCE AVAILABLE."
  - 2. Emergency Power Supervision: Red light with nameplate engraved "EMERGENCY SOURCE AVAILABLE."
- H. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 Amp at 240 Volt AC.
- I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
- J. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open. Rated 10 Amp at 32 Volt DC minimum.
- K. Engine Shutdown Contacts: Time delay adjustable from 0 to 5 minutes. Factory set for 5 minutes. Contacts shall initiate shutdown at packaged engine generator controls after retransfer of load to normal source.
- L. Packaged Engine Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods adjustable from 10 to 30 minutes. Factory settings for 7 day exercise cycle, 20 minute running period, and 5 minute cool-down period. Exerciser features include the following:
  - 1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - 2. Push-button programming control with digital display of settings.
  - 3. Integral battery operation of time switch when normal control power is not available.

## 2.05 BYPASS/ISOLATION SWITCHES

- A. Description: Manual type arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
  - 1. Means to lock bypass/isolation switch in position that isolates transfer switch with arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer switch operation except for testing or maintenance.
  - 2. Drawout Arrangement for Transfer Switch: Includes physical separation from live parts and accessibility for testing and maintenance operations.
  - 3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch and with same phase arrangement and number of poles.
  - 4. Contact temperatures of bypass/isolation switches do not exceed those of automatic transfer switch contacts when carrying rated load.
  - 5. Operability: Constructed so load bypass and transfer switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.

6. Legend: Manufacturer's standard legend for control labels and instruction signs give detailed operating instructions.
  7. Maintainability: Fabricate to allow removal of major components from front without removing other parts or main power conductors.
- B. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory installed copper bus bars. Plated at connection points and braced for available short-circuit current.

## 2.06 FINISHES

- A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

## 2.07 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1. Submit test results and include copy in the Operation and Maintenance Manual.

## PART 3 - EXECUTION

### 3.01 TRANSFER SWITCH INSTALLATION

- A. Comply with requirements in Section 26 05 48 for mounting and anchoring.

### 3.02 WIRING TO REMOTE COMPONENTS

- A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

### 3.03 CONNECTIONS

- A. Comply with requirements in Section 26 05 26 for grounding.
- B. Comply with requirements in Section 26 05 19 for wiring connections.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not available, use those specified in UL 486A and UL 486B.

### 3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Comply with requirements in Section 26 08 10. Include copy of field test reports in the Operation and Maintenance Manual.

- B. Perform the following field tests and inspections:
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters.
  3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - a. Check for electrical continuity of circuits and for short circuits.
    - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - c. Verify that manual transfer warnings are properly placed.
    - d. Perform manual transfer operation.
  4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least 3 times.
    - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    - c. Verify time-delay settings.
    - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    - e. Test bypass/isolation unit functional modes and related automatic transfer switch operations.
  5. Coordinate tests with tests of packaged engine generator and run them concurrently.
  6. Submit report results of tests and inspections and include copy in the Operation and Maintenance Manual. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach label or tag to each tested component indicating satisfactory completion of tests.
  7. Remove and replace malfunctioning units and retest as specified above.

3.05 **DEMONSTRATION AND TRAINING**

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Comply with requirements in Section 26 05 10.
- B. Coordinate training with that for packaged engine generator equipment.

\*\*\* END OF SECTION \*\*\*



**SECTION 26 43 13**  
**SURGE PROTECTIVE DEVICES**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes Surge Protective Devices (SPD) and associated appurtenances used for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients. This specification also describes the mechanical and the electrical requirements for the SPD. The SPD shall be suitable for application in Category A, B and C environments as described in ANSI/IEEE C62.41- 2002.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to Work in this section.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
  - 1. ANSI/UL 1449 Third/Fourth Edition, Standard for Safety for Surge Protective Devices.
  - 2. ANSI C84, American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hertz).
  - 3. IEEE C62.41.1, Guide on the Surge Environment in Low-Voltage (1,000 V and Less) AC Power Circuits.
  - 4. IEEE C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and Less) AC Power Circuits.
  - 5. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuit.
  - 6. IEEE 142, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book).
  - 7. IEEE 1100, IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).
  - 8. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  - 9. NFPA 70, National Electrical Code (NEC).
  - 10. UL 1283, Standard for Safety for Electromagnetic Interference Filters.
- C. Units listed and labeled by OSHA Nationally Recognized Test Lab (NRTL). Comply with NEC as applicable to SPDs.
- D. SPDs provided by a single manufacturer.

E. Manufacturer Qualifications:

1. Manufacturer shall have local representation and distribution within 400 miles of the project location to provide installation, technical, warranty, and site observation support services for the project.
2. Manufacturer/vendor must be capable of supplying SPD for project within 30 days of receipt of order for orders of 25 units and less for models submitted in response to this specification.
3. Manufacturers shall be certified to latest ISO 9001 standard and shall be registered for the design and manufacturing of SPD devices.
4. Manufacturer shall provide access to a readily available factory Engineer for answering questions about this product.
5. Only firms regularly engaged in the manufacture of SPD products for category C locations (ANSI/IEEE C62.41.1-2002), and whose products have been providing satisfactory service for not less than five years, shall be considered. Upon request, provide a customer reference list, with a minimum of five contact names and current phone numbers. Additional minimum SPD performance requirements apply. Contact the Owner for details.

1.04 **SUBMITTALS**

A. Comply with requirements in Division 01 and Section 260500.

B. Certifications:

1. Specification compliance response sheet referencing each specification section.
2. Proof of ANSI/UL 1449 Third/Fourth Edition compliance from Nationally Recognized Test Lab (NRTL) accepted by local authority having jurisdiction.
3. ANSI/UL 1449 Third/fourth Edition Nominal Discharge Current Rating and Voltage Protection Ratings.
4. UL 1283 filter compliance documentation.
5. Performance/warranty information.
6. Manufacturer Qualifications.

C. Product Data:

1. Submit manufacturer's technical product data, installation instructions, maintenance data, and general recommendations for each type of SPD.
2. Reference appropriate ANSI/UL 1449 Third/Fourth Edition and IEEE C62.41 performance ratings for intended installation locations.
3. SPD not listed within specification requires pre-approval by the Owner and submission of SPD performance data not listed in this specification. Contact the Owner for required performance criteria.

1.05 **WARRANTY**

A. Minimum requirements:

1. Period: 20 years from the date of substantial completion of service and activation of the system to which the SPD is attached.
2. Full replacement of a suppressor which is damaged or fails to meet manufacturers published specifications and specifications provided within, without pro-rating value.

3. No exclusions from failure or damage from any system anomaly (over-voltage, single phasing, lightning strike, etc. (IEEE 62.41.1). Exceptions: failure caused by wiring error, loose or missing Neutral to Ground Bond or Megger Testing with SPD connected to power system.
4. Factory or third party testing shall not be required.
5. Warranty shall apply independent of facility ownership/purchaser.
6. Replacement unit to be at facility within 7 business days of receipt of written notification of failure at no cost to the customer (exception – custom configuration or special order units).
7. Replacements: same make, model and configuration as original unit unless otherwise requested or approved.
8. Manufacturer site visit for validation of warranty claim: manufacturer/vendor must visit site within 3 days of notification at no cost.
9. No shipping, handling, examination or other fees are allowed.

**1.06 DELIVERY, STORAGE AND HANDLING**

- A. Inspect for damage and replace any damaged device.
- B. Store in a clean, dry space suitable for equipment and protect against damage.
- C. Clean equipment and touch up minor scratches using suitable materials.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Surge Protective Devices:
  1. Innovative Technology.
  2. Current Technologies.
  3. No substitutions.
- B. Service Entrance:
  1. Innovative Technology:
    - a. 480Y/277V Model PTX160-3Y-201-MT.
    - b. 208Y/120V Model PTX160-3Y-101-MT.
  2. Current Technologies:
    - a. 480Y/277V Model CG80-277/480-3GY.
    - b. 208Y/120V Model CG80-120/208-3GY.
- C. Distribution Boards - 800A and higher:
  1. Innovative Technology:
    - a. 480Y/277V Model PTX080-3Y-201-MT.
    - b. 208Y/120V Model PTX080-3Y-101-MT.

2. Current Technologies:
  - a. 480Y/277V Model CG60-277/480-3GY.
  - b. 208Y/120V Model CG60-120/208-3GY.

D. Panelboards below 800A:

1. Provide with Active Sinewave Tracking.
2. Innovative Technology:
  - a. 480Y/277V Model PTE080-3Y-201-MT.
  - b. 208Y/120V Model PTE080-3Y-101-MT.
3. Current Technologies:
  - a. 480Y/277V Model CGF40-277/480-3GY.
  - b. 208Y/120V Model CGF40-120/208-3GY.

2.02 DESIGN AND PERFORMANCE REQUIREMENTS

A. Design:

1. SPD shall be compatible with the electrical system voltage, current, system configuration and intended applications and shall be NRTL listed for such application.
2. Parallel design only with individual protection components:
  - a. Line to Ground and Line to Line for Delta and High Resistance Grounded systems.
  - b. Line to Ground, Line to Neutral and Neutral to Ground for Wye and Single Phase distribution systems.
3. Metal-Oxide Varistors (MOV) components shall be utilized. Selenium cell, air gaps, gas tubes or other components are not allowed.
4. Maximum continuous operating voltage (MCOV) of all components (based on ANSI C84.1 standard voltages), shall be not less than 125% for 120/208 and 120/240V systems and not less than 115% for all other systems.
5. Short Circuit Current Ratings (SCCR) shall be  $\geq 100\text{kAIC}$  and not less than 115% of available fault current for location SPD is to be installed.
6. Visual indication of protection status on each phase, visible from the front of the equipment.
7. Protection Status:
  - a. Normally open and normally closed contacts for remote monitoring.
  - b. Rated a minimum of .5 Amps, AC or DC.
  - c. Shall change state upon device failure or loss of power.
8. As a minimum, Branch Panel, Sub-Panel and series installed (branch circuit) SPD shall include a passive circuit which allows the SPD to actively follow the voltage waveform and provide a clamping envelope to limit low level IEEE C62.41 ringwaves (of either polarity) at all locations on the sine wave.
9. Complete, comprehensive installation instructions shall be provided for the SPD.

10. Enclosure:
- a. NEMA rated metal enclosure appropriate for environmental conditions and exposure at point of installation.
  - b. Designed to allow connection of the SPD without sharp bends in the conductors.
  - c. Provide metallic flush cover where installed in finished areas.

B. Performance and Ratings:

1. Minimum durability and performance requirements are described below in accordance with test procedures outlined in ANSI/IEEE C62.45 & ANSI/UL 1449 Third/Fourth Edition. Test documentation shall be provided as part of the submittal package. Information shall be provided in a format which is easily to analyze and review. The following test data shall be submitted as manufacturer published literature:
- a. Provide Peak Surge Current (Single Pulse Rated, 8/20 $\mu$ S, by mode, Amperes with  $\leq$  10% degradation) with submittals document for each SPD proposed. For all electrical equipment located at Service Entrance or Category C locations, Surge current rating (per mode) shall be a minimum of 80kA for IEEE C62.41.1-2002 - Category C Medium and Low Exposure Locations (low lightning exposure as determined by Isokeraunic Map) and a minimum of 300 kA for IEEE C62.41.1-2002-Category C High Exposure locations (high lightning exposure as determined by Isokeraunic Map) or for mission critical facilities such as hospitals or data centers. For SPDs with component level fusing, manufacturer shall provide recommended peak surge current ratings as necessary to meet durability requirements provided for in this specification.
  - b. Provide independent NRTL laboratory proof of completion of such tests and test data with submittal data. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G & N-G) with submittals.
  - c. Surge current rating (per mode) shall be a minimum of 40 kA for branch panel models for IEEE C62.41.1-2002 - Category B & C Switchboard Locations where upstream protection is provided by Service Entrance SPD. For SPDs with component level fusing manufacturer shall provide recommended peak surge current ratings as necessary to meet durability requirements provided in this specification.
  - d. Provide EMI/RFI Attenuation with submittals as per Mil Std-220 tests. Attenuation: 40 dB at 100 kHz.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.

- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

### 3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Drawings.

### 3.04 FIELD QUALITY CONTROL

- A. Comply with requirements in Section 260810. Include copy of field test reports in the Operation and Maintenance Manual.

### 3.05 SPD INSTALLATION

- A. General Application & Installation Requirements:
  - 1. Per the manufacturer's installation instructions.
  - 2. Per electrical installation detail (when provided).
  - 3. Per Installation Checklist.
  - 4. NFPA 70 (NEC) Requirements.
  - 5. Per IEEE C62.41.2, 141, 142 and 1100.
  - 6. Local authority having jurisdiction.
- B. Use approved Flush Mount Kits for External Device Flush Mount Installations. Metallic flush kits for flush mount installations (external devices) on new and retrofit applications for panels. Kits shall include supports for fastening to structural members and shall include a face plate matching SPD finish. Retrofit kits shall be capable of being installed next to the panel after drywall has been installed without the need for patching or refinishing of the wall. At contractor's option, provide custom manufactured flush mounting kit including supports for fastening to structural members and face plate matching SPD finish to manufacturer and obtain written approval prior to submittals.
- C. Units shall not tap directly to the bus without upstream over-current protection unless tap conductors are protected at their termination by NRTL listed Disconnect, Over-current and Short Circuit Protective Devices (Circuit Breaker) properly rated for conductor and SPD Device Protection as per SPD NRTL listing and NEC requirements. Properly rated short circuit and overcurrent protection device shall always be installed at the source (i.e., in switchboard, panelboard, or other electrical apparatus) unless approved by the Owner.
- D. Manufacturer/vendor shall provide technically qualified personnel as necessary to visit project site for pre-installation training of contractor.
- E. Contractor shall contact manufacturer/vendor to arrange for on-site training, and shall submit written documentation of training (including meeting minutes listing; attendees, training dates, subject covered, etc.) to Owner within 15 business days of training date. Training shall include:
  - 1. Mounting of SPDs and Flush Mount Kits (where applicable).
  - 2. Proper installation of SPD leads for minimal let through voltage.

3. General SPD ratings (i.e., voltage, peak surge current, etc.) and appropriate installation and application.
  4. Overcurrent and short circuit protection requirements.
- F. Specific project installation requirements as per drawings, specifications and Owner's communication.
- G. Clean SPD units and flush mount covers and touch up with matching paint as necessary. SPDs and Flush Mount Plates with physical damage will not be accepted.
- H. Manufacturer or vendor shall provide technically qualified personnel as necessary to conduct review of SPD installation as needed to confirm proper installation of all SPDs.
- I. Manufacturer/vendor personnel performing site visit shall, as a minimum:
1. Be qualified to evaluate installation.
  2. Be "Qualified" as per OSHA requirements.
  3. Have appropriate Electrical Personal Protective Equipment as per state and federal OSHA requirements and NFPA 70E.
  4. Have appropriate electrical safety training on arc flash, arc blast and electrical shock hazards.
  5. Have, and follow a written electrical safety program based on state and federal OSHA requirements and NFPA 70E.
- J. It is responsibility of manufacturer/vendor to provide appropriate training, procedures, equipment, etc. as necessary to help ensure workers safety. Owner is not responsible for minimum safety requirements, safety review or safety planning for manufacturer/vendor personnel.
- K. Contractor shall contact manufacturer/vendor to arrange for inspection of SPD installation, and shall submit written documentation of manufacturer/vendor inspection (including meeting minutes listing; attendees, training dates, inspection report, noted deficiencies, additional subjects covered, etc.) to Owner within 15 business days of inspection date. Inspection shall review and document installation by physical location, including:
1. Mounting of SPDs and Flush Mount Kits (where applicable).
  2. Proper installation of SPD leads for minimal let through voltage.
  3. SPD ratings (i.e., voltage, peak surge current, etc.) and appropriate installation and application.
  4. Overcurrent & short circuit protection requirements.
  5. Compliance with project installation requirements as noted in specifications, one-line drawing details and specific written communication of special installation requirement provided by Owner.
- L. The Owner or their appointed representative, may also perform inspection of the installed SPDs. Owner reserves the right to document installation deficiencies and require additional corrections to the installation as necessary to comply with manufacturer installation requirements, project requirements and specifications.
- M. Use a low impedance cable assembly at locations where more than 30" of conductor is required to connect the SPD to a circuit breaker.
1. Acceptable manufacturer: Current Technology HPI Series or equivalent.

- N. A final installation report shall be submitted to the Owner as part of project operations and maintenance documentation. Final installation report shall include inspection documentation and documentation confirming correction of all noted installation deficiencies.

### 3.06 SERVICE ENTRANCE

A. Service Entrance Installation Requirements:

1. One primary suppressor at each utility service entrance to the facility or as indicated on the drawings.
2. Suppressors shall be connected to properly rated disconnect with overcurrent and short circuit protective device connected on the load side of the service entrance disconnecting means in accordance with NEC requirements and manufacturer installation instructions.
3. Conductors between suppressor and point of attachment shall be kept as short and straight as possible and shall be twisted together.
4. Suppressor's ground shall be bonded to enclosure frame and the service entrance ground bus, and conduit between the SPD and the switchboard must provide secure electrical/mechanical connections.
5. SPD shall be NRTL labeled with at 200 kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.
6. SPD shall be NRTL labeled as Type 1 or Type 2 as necessary for installation (verifiable at NRTL website).
7. All field applied devices require the NRTL Listing with appropriate label reflecting such listing.

### 3.07 SECONDARY SUPPRESSORS FOR DISTRIBUTION & BRANCH PANELS

A. Distribution Centers, and Branch Panel applications:

1. Install one secondary suppressor at each Distribution Panel, and Branch Panel/Sub-Panel location or as indicated on the drawings.
2. Suppressor shall be connected to properly rated disconnect with overcurrent and short circuit protective device in accordance with NEC requirements and manufacturers installation instructions.
3. The SPD shall not limit the use of feed through lugs, sub-feed lugs and sub-feed breaker options. Where feed through lugs, bus tap or circuit breaker is used to feed adjacent sub-panel, SPD shall be installed at first panel served by feeder and conductor terminations between primary panel and adjacent panel shall be installed in such a manner to keep wiring as short as possible (i.e., use bottom lug on output of panel and bottom lugs on input of second panel).
4. Conductors between suppressor and point of attachment shall be kept as short and straight as possible and shall be grouped and twisted together. Mount the SPD directly adjacent to the circuit breaker closest to the neutral bus, so the maximum length of connecting wiring shall not exceed 18 inches for all leads without written permission of the Owner.
5. Suppressor's ground shall be bonded to enclosure frame and the equipment ground bus, and the electrical fitting between the SPD and the switchboard must provide secure electrical/mechanical connections.
6. The electrical gear shall be capable of being re-energized upon removal of the SPD.



7. SPD shall be NRTL labeled as Type 1 or Type 2 (verifiable at NRTL website) as necessary for installation.

\*\*\* END OF SECTION \*\*\*

**SECTION 26 51 00  
LIGHTING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes interior and exterior luminaires, lamps, ballasts/drivers and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01, and Sections 260500, and 260510 apply to Work in this section.
- C. Comply with requirements in other specification sections for concrete used for embedding poles, pole foundations, and footings for exterior area luminaire poles, standards, and foundations. Pole bases included in this section.
- D. Where conflict occurs, the Luminaire (Light Fixture) Schedule shall take precedence.

**1.02 RELATED REQUIREMENTS**

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

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards: NFPA 70, National Electrical Code (NEC), including local amendments, as applicable.
- C. Comply with NEC and NEMA for installation and construction of luminaires. Components, Devices and Accessories shall be listed and labeled for intended use as defined in NEC, by a qualified testing agency and acceptable to the AHJ. Luminaires shall be UL listed and be labeled.
- D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- E. Each lamp type shall be of the same manufacturer.
- F. Each ballast type shall be of the same manufacturer.
- G. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- H. Luminaires in damp or wet locations shall be listed for such use and labeled as either "Suitable for Damp Locations" or "Suitable for Wet Locations".

1.04 **SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data and maintenance data for each type of luminaire and appurtenance.
  - 1. Submit product data for associated lamp, ballast (or driver) for each luminaire type.
  - 2. Create a matrix encompassing all luminaire types with ballast and lamp type, including manufacturer name and part number(s).
  - 3. Submit copy of individual and/or tandem warranties for luminaire, lamp and ballast (or driver), as applicable.
  - 4. For solid state lamps:
    - a. Provide IES LM-79 report.
    - b. Provide IES TM-21 report.
    - c. Provide Bin Coding System Chart, with appropriate target CCT reference line, identifying which bin corresponds to the lamps supplied to each luminaire. For luminaires with multiple solid state lamps, identify which bins shall be included for color mixing.
- C. Qualifications: Indicate manufacturer qualifications as identified in Part 2.
- D. Shop Drawings:
  - 1. Submit dimensioned drawings of each type of luminaire. Submit in booklet form with separate sheet for each luminaire, assembled by luminaire "type" in alphabetical order with proposed luminaire and appurtenances clearly indicated on each sheet.
  - 2. Submit support and hanging details for luminaires weighing more than 56 pounds and pendant hung luminaires requiring support design approved by the AHJ.
  - 3. Submit copy of manufacturer installation instructions for each luminaire type.
- E. Test Reports:
  - 1. Comply with commissioning requirements in Section 260810.
  - 2. Perform field test reports.
  - 3. Submit completed copy of reports at the time of substantial completion. Include copy in the Operation and Maintenance Manual.

1.05 **DEFINITIONS**

- A. CU: Coefficient of utilization.
- B. HID: High-intensity discharge.
- C. HO: High output.
- D. IC: Insulation contact.
- E. Lamp: The complete light source package, including all associated components (base, pins, filament, outer bulb, solid state components, etc.) that make up a single unit.
- F. Light: Radiant energy sensed or seen.

- G. Light Fixture: Luminaire.
- H. Lumens: Measured light output of lamp (or luminaire if using solid state lamping).
- I. Luminaire: A complete lighting unit consisting of a lamp, ballast (or driver) as required together with the parts designed to distribute the light and to position and protect the lamp, as well as the electrical parts required to generate the light. This may include the means to connect to a power supply.
- J. Rated Lamp Life:
  - 1. Solid State lamps: L-70, the time after which 70% of the initial lumen output is maintained out of the respective luminaire.

**1.06 COORDINATION**

- A. Review luminaire types with respective ceiling type prior to ordering. Initiate a meeting with the ceiling installer and issue meeting minutes to the A/E. Inform A/E where mounting method conflict occurs.
- B. Review luminaire types with location of building insulation prior to ordering. Initiate a meeting with the insulation installer and issue meeting minutes to the A/E. Inform A/E where non-IC rated luminaires are in conflict with the building insulation.
- C. Review luminaire types with final millwork shop drawings. Initiate a meeting with the casework installer and issue meeting minutes to the A/E. Verify luminaires will fit where specified in or adjacent millwork prior to rough-in.
- D. Coordinate layout and installation of luminaires and associated support methods with all trades.

**1.07 WARRANTY**

- A. Comply with requirements in Division 01 and Section 260500 – Warranty.
- B. Warranty period as indicated in Section 260500 shall establish minimum requirement, unless otherwise noted.
- C. Solid State Lamps and Drivers: 5 years.
- D. Batteries (in luminaires or unit equipment): Manufacturer's standard form in which manufacturer shall repair or replace components of rechargeable batteries that do not comply with minimum Code required life, within 5 years.
- E. Generator Transfer Device: 5 years.

PART 2 - PRODUCTS

2.01 LUMINAIRES

- A. Housing: Metal parts shall be free from burrs, sharp corners and edges. Sheet metal components shall be formed and shall not warp or sag. Luminaires shall be free of light leaks while also providing the required ventilation so as not to degrade the rated photometric performance and rated life of lamps and/or ballasts. Adjustable luminaires shall utilize positive locking devices to set aiming angle; luminaire shall be able to be relamped without affecting aiming angle.
- B. Lenses: Where utilized, acrylic plastic shall be 100% virgin acrylic, highly resistant to yellowing and other changes due to aging, exposure to heat and ultraviolet radiation. Minimum thickness of 0.125 inches.
- C. Hardware: Finish ferrous mounting hardware and accessories to prevent corrosion and/or discoloration to any and all adjacent materials. Hardware for steel or aluminum luminaires shall be cadmium, or approved, plated. Hardware for stainless steel luminaires shall be stainless steel. Hardware for bronze luminaires shall be stainless steel or bronze.
- D. Reflecting Surfaces: The following minimum reflectance values shall be met:
  - 1. White Surfaces: 85%.
  - 2. Specular Surfaces: 90%.
  - 3. Anodized Aluminum Surfaces: 93%.
- E. Latches: Latches for luminaire doors/louvers, where applicable, shall be spring type and shall operate freely and easily without excessive force.
- F. Wiring
  - 1. Cords/cables between luminaire components shall have a minimum temperature rating of 105°C.
  - 2. Cords/cables shall be fitted with appropriate strain relief connectors and/or weathertight entries, where required by application.
  - 3. No internal wiring shall be visible from normal viewing angles.
  - 4. Cords/cables to pendant luminaires shall match color of respective canopy.
  - 5. Internal and/or factory wiring shall be a minimum size of 18 AWG.

2.02 LAMPS

- A. Refer to Luminaire (Light Fixture) Schedule for additional information.
- B. Notify and send A/E manufacturer's recommendations for lamp/ballast combination if different from products specified.
- C. Solid State:
  - 1. LED:
    - a. Manufacturers:
      - 1) Minimum of 5 year history of producing and/or installing LEDs in North America.

- 2) Philips/Lumileds, Osram/Sylvania, General Electric, Cree, Nichia, Samsung, or approved.
  - b. Minimum CRI of 85.
  - c. Lamps shall not use any energy when 'off'.
  - d. CCT throughout life of lamp shall be within +/- 200 K of respective specified value.
2. Organic LED lamps are not allowed.

### 2.03 BALLASTS AND DRIVERS

- A. Refer to Luminaire (Light Fixture) Schedule for additional information.
- B. Notify and send A/E manufacturer's recommendations for lamp/ballast combination if different from products specified.
- C. Quantities: For continuous linear light fixtures provide quantity of ballasts/drivers required to support the circuiting and control shown on the contract documents.
  1. Daylight zones: Provide drivers for control within daylight zones for linear fixtures that are mounted in any portion of a daylight zone. If 50% or more of a control length is in a daylight zone it shall be controlled within that zone.
  2. For linear lengths that cross primary/secondary zones control with the more stringent daylight zone.
  3. Control Length: Maximum eight foot, minimum four foot.
- D. Solid State Drivers/Power Supplies:
  1. Manufacturers:
    - a. Minimum of 5-year history of producing and/or installing drivers in North America.
    - b. Philips/Advance, Osram Sylvania, General Electric, Universal, Thomas Research, or approved.
  2. When not in the luminaire, the housing shall be plenum rated.
  3. Poke-in wire trap connectors or integral leads color coded per ANSI C82.11.
  4. Withstand +/- 10% voltage fluctuation with no compromise of performance or life cycle.
  5. +/- 5% output across published load range.
  6. 120-277 Volt rating.
  7. PF greater than 0.9, at specified voltage.
  8. Minimum efficiency of 80% at rated full load.
  9. Maximum case temperature rating of 70°C.
  10. THD less than 20%.
  11. Class A sound rating.
  12. Minimum operating temperature of -20°F.
  13. Shall tolerate sustained open circuit and short circuit output conditions without damage and without need for external overcurrent protection.
  14. No PCB allowed.
  15. Comply with ANSI/IEEE C62.41.1 & C62.41.2, Category A for transient protection.
  16. Dimmable, as specified in the Luminaire (Light Fixture) Schedule.

2.04 EGRESS

- A. UL 924 Listed.
- B. Battery Packs (Emergency Ballasts) in General Luminaires:
  - 1. Manufacturers: Philips/Bodine, Iota Engineering, or approved.
    - a. Solid State driver assemblies with integrated components are allowed.
  - 2. Must fit inside luminaire's ballast compartment. In case of remote ballast installation, battery pack shall be installed adjacent ballast and marked accordingly on the record drawings (as-builts).
  - 3. Must initiate within 3-10 seconds of power failure and allow for 90 minutes of operation.
  - 4. Compatible with 1-lamp, 2-lamp, 3-lamp, 4-lamp and dimming ballasts.
  - 5. Allow for multi-lamp operation.
  - 6. 120/277 Volt rating.
  - 7. End-of-lamp-life compatible.
  - 8. Damp listed.
  - 9. High temperature, maintenance-free nickel-cadmium sealed battery, minimum 7 years of operation.
  - 10. Must automatically switch back to normal power once available.
  - 11. Test switch, located inside the luminaire if possible; if not possible, notify A/E and locate switch and indicator light per A/E direction prior to rough-in.
- C. Unit Equipment:
  - 1. Manufacturers: Hubbell Lighting/Dual-Lite, Cooper Lighting/Sure-Lites, Acuity Brands/Lithonia, Philips/Chloride, Philips/Lightolier, or approved.
  - 2. Must initiate within 3-10 seconds of power failure and allow for 90 minutes of operation.
  - 3. Maintenance-free lead-calcium sealed battery, minimum 7 years of operation.
  - 4. Must contain visual indicator status of normal power.
  - 5. Automatic self-diagnostic monitoring and testing of unit operation. Self-test every 28 days.
    - a. Must contain visual indicator status of service alerts for 'battery fault', 'charger fault', 'transfer fault' and 'lamp fault'.
    - b. Manual test switch.
  - 6. Must automatically switch 'off' once normal power is available.
  - 7. Automatic low voltage disconnect battery protection.
  - 8. Automatic normal power lockout circuit.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory. Work that requires modification due to unsatisfactory conditions, deemed by the A/E, shall be corrected and completed to the satisfaction of the A/E at no additional cost to the contract.

3.02 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.03 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.
- B. Temporary Lighting for Construction Use: Contractor shall provide lighting used during the construction period for construction tasks. Permanent luminaires that are part of the project may not be utilized for this use.
- C. Remote Mounting of Ballasts (where indicated on the drawings and/or approved by the A/E): Distance between the remote ballast and respective luminaire shall not exceed distance recommended by the ballast manufacturer. If recommended distance conflicts with the drawings, notify the A/E prior to rough-in.

3.04 INTERIOR LUMINAIRE INSTALLATION

- A. Install luminaires at locations and heights as indicated on the Drawings, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NESC, NECA's "Standards of Installation", NEMA standards, and recognized industry practices to ensure that luminaires fulfill requirements. Luminaires shall be installed exactly level, secure and plumb with respective building lines. Wall mount and ceiling mount luminaires shall be securely and tightly attached to their respective mounting surface. Lay-in luminaires shall sit flush with grid ceiling system, doors shall swing completely open in the designed direction.
- B. Luminaire Supports:
  - 1. General: Comply with IBC and NEC (including all local amendments) as interpreted by AHJ for luminaires mounted in suspended ceilings. Lay-in and pendant luminaires shall not be supported by lay-in suspended grid ceiling system and must be attached to structure.
  - 2. Support Requirements:
    - a. Include flexible ball joint hangers for pendant and stem hung luminaires at designated points of support.



- b. Equip hooks used to hang luminaires with safety latches. Include supports, brackets, clips, screws and miscellaneous items for mounting luminaires.
  - c. Include locking catches, screws, safety chain(s) or safety cable(s) for detachable luminaire parts, luminous ceiling accessories, louvers, diffusers, lenses and reflectors.
3. Seismic Restraints:
- a. For Luminaires Weighing Less than 10 Pounds: Install (1) slack No. 12 gauge hanger wire from luminaire to structure above.
  - b. For Luminaires Weighing 10 to 56 Pounds: Install (2) independent slack No. 12 gauge hanger wires from opposite corners of luminaire to structure above.
  - c. For Luminaires Weighing More than 56 Pounds: Support directly from the structure above by hangers approved by the AHJ. Comply with requirements in Section 260548 for seismic restraints.
  - d. For Pendant Hung Luminaires: Support directly from structure with No. 9 gauge hanger wire or alternate support without using ceiling suspension system for direct support approved by the AHJ. Comply with requirements in Section 260548 for seismic restraints.
- C. Fire Rated Assemblies: Provide gypsum board protection acceptable to the AHJ to ensure fire rating of ceiling or wall in which luminaires are installed. Maintain manufacturer's recommended ventilation requirements.
- D. Provide backing in wall cavity to reinforce support for wall mounted luminaires.
- E. Luminaire Contact with Building Insulation: When building insulation is installed at a location where contact with luminaires is unavoidable, IC-Rated luminaires shall be utilized. Where insulation is present and an approved IC-Rated luminaire is not available, provide a gypsum board assembly around the luminaire, maintaining all recommended ventilation requirements, to separate luminaire from adjacent insulation.
- F. Protect installed luminaires from damage during construction period through date of substantial completion. Damaged luminaires, including associated components, shall be replaced in their entirety.
- G. Installed in a Shower or Wet Location: If luminaires have exposed metal parts that are grounded, respective circuit breakers shall be GFCI. If luminaires have exposed metal parts that are not grounded, they shall not be utilized and an approved luminaire without exposed metal parts shall be provided. Inform A/E prior to ordering luminaires.
- H. Exit Signs: Verify color of lettering with AHJ prior to ordering.

### 3.05 EXTERIOR LUMINAIRE INSTALLATION

- A. Coordinate with work of other trades as necessary to properly interface installation of exterior lighting.

- B. Install lighting poles and standards plumb on concrete pole bases as indicated on the Drawings with anchor bolts and reinforcing bars. Coordinate anchor bolt size, pattern and orientation prior to base installation. Coordinate size and location of bases prior to installation. Hand rub exposed concrete to uniform, smooth finish. Support during backfilling and anchoring to foundations. Comply with requirements in Section 260510 for excavation and backfilling. Refer to Contract Drawings for additional information.
- C. Fuses for Exterior Pole-Mount Luminaires: Include fuses in each phase conductor, sized for 1-1/2 times maximum full load ballast current served by each conductor, Bussmann KTK or approved. Do not exceed circuit overcurrent protective device rating. Include fuse holder at handhole or in base junction box with "breakaway" receptacles for conductors running to top of poles, Bussman HEB or approved. Include fuse blanks in neutral conductors.
- D. Install with sufficient space for hand access and cable entrance holes for installation of underground cabling. Make splices in pole or pole base using Scotchcast 400 resin for watertight connections.
- E. Wall Mount: Exterior building mount luminaires shall coordinate/align with building elements. Luminaires and respective mounting and rough-in means shall align in the center of building elements and shall not split unevenly across multiple elements. Notify A/E of conflicts prior to rough-in.

**3.06 FIELD QUALITY CONTROL**

- A. Upon completion of installation of luminaires and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Repair malfunctioning units on site, then retest to demonstrate compliance. If not possible to repair on site, remove and provide new units and retest. Include copy of test reports in the Operation and Maintenance Manual.
- B. Clean luminaires in their entirety of dirt and debris upon completion of installation, including but not limited to housing, lens(es), lamp(s) and louver(s) within (7) days of substantial completion.
- C. At Substantial Completion, remove and provide new lamps in interior and exterior luminaires which are observed to be noticeably dimmed due to Contractor's use and testing, as judged by the A/E.

\*\*\* END OF SECTION \*\*\*

**SECTION 27 00 00  
COMMUNICATIONS WORK SPECIFIED IN DIVISION 26**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

A. Description: The following sections apply to Work in this Division:

- |     |                |  |
|-----|----------------|--|
| 1.  | Section 260500 | General Electrical Provisions                                  |
| 2.  | Section 260510 | Basic Electrical Materials and Methods                         |
| 3.  | Section 260511 | Electrical Connections for Equipment                           |
| 4.  | Section 260519 | Wire and Cables  |
| 5.  | Section 260527 | Telecommunications Grounding System                            |
| 6.  | Section 260529 | Supporting Devices   |
| 7.  | Section 260533 | Raceway Systems  |
| 8.  | Section 260534 | Outlet Boxes   |
| 9.  | Section 260535 | Floor Outlet Boxes   |
| 10. | Section 260536 | Cable Trays  |
| 11. | Section 260543 | Underground Vaults and Raceways                                |
| 12. | Section 260548 | Vibration Isolation and Seismic Control for Electrical Systems |
| 13. | Section 260553 | Electrical Identification                                      |

**PART 2 - PRODUCTS**

Not used.

**PART 3 - EXECUTION**

Not used.

\*\*\*END OF SECTION\*\*\*

**SECTION 27 11 00  
TELECOMMUNICATIONS SYSTEM**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Work includes the following:
1. Structured Cabling System supporting various low-voltage systems
  2. Telecommunications Rooms and Spaces
  3. Grounding and Bonding Infrastructure
  4. Manufacturer Certification
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and 260500 sections apply to Work in this section.

**1.02 RELATED SECTIONS**

- A. Related Sections
1. 260500 – General Electrical Provisions
  2. 260510 – Basic Electrical Materials and Methods
  3. 260527 – Telecommunications Grounding System
  4. 260533 – Raceway Systems
  5. 260534 – Outlet Boxes
  6. 260535 – Floor Outlet Boxes
  7. 260536 – Cable Trays
  8. 260543 – Underground Vaults and Raceways

**1.03 QUALITY ASSURANCE**

- A. Regulatory Requirements: Comply with applicable city, county, and state codes and ordinances.
- B. Codes and Standards:
1. Installation Standards: Comply with following standards for cable and equipment installations. Publications shall be latest issue and addenda:
    - a. NEC, National Electric Code.
    - b. NESC, National Electric Safety Code.
    - c. TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises.
    - d. TIA-568-C.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
    - e. TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
    - f. TIA-568.3-D, Optical Fiber Cabling Components Standards.
    - g. TIA-569-D, Commercial Building Standard for Telecommunications Pathways and Spaces.

- h. TIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Building.
  - i. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises.
  - j. TIA-758-B, Customer Owned Outside Plant Telecommunications Cabling Standard.
  - k. TIA-862-B, Structured Cabling Infrastructure for Intelligent Building Systems.
  - l. TIA-526-7, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7.
  - m. TIA-526-14-B, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant-OFSTP-14.
  - n. IEEE 802.3-2000. Ethernet Standard.
  - o. BICSI 001, Information Transport Systems Design Standard for K-12 Educational Institutions.
  - p. BICSI Information Transport Systems Installation Methods Manual.
  - q. BICSI Telecommunications Distribution Methods Manual.
2. Contractor shall have read the above documents and shall be familiar with the requirements that pertain to this installation. The documents may be obtained from:
- a. Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, <http://global.ihs.com/>
  - b. BICSI, 8610 Hidden River Parkway, Tampa, FL, 33637, 800-242-7405, [www.bicsi.org](http://www.bicsi.org)
3. Materials:
- a. UL listed and labeled. Install label to be visible.
  - b. Equipment: Regularly catalogued items of manufacturer and supplied as complete unit in accordance with manufacturer's standard specifications with optional items required for proper installation unless otherwise noted in this section.
  - c. Telecommunications connectivity and cabling independently tested to meet current TIA standards.
- C. Qualifications:
1. Contractor performing work specified in this section is required to have special skills obtained by education, experience, or both.
  2. Contractor's bidding work specified herein shall have a minimum of seven years of experience in the construction, testing, and servicing of systems of the type and magnitude specified in this section.
  3. Contractor shall be a certified installer of the telecommunications system and pre-qualified by the manufacturer for the purpose of offering the Applications Assurance warranty at the time of bid.
  4. Contractor shall have direct access to the tools and test equipment required to complete the Work at the time of bid.
  5. Project manager (in office) and superintendent (field) shall have 5 years of experience at project manager and superintendent levels, respectively, on completed telecommunications projects of like magnitude and complexity as to this project. Project manager shall be certified as a Registered Communications Distribution Designer (RCDD) through Building Industry Consulting Service International (BICSI).
    - a. RCDD shall be a direct employee of the company bidding on said Work.

6. Field technicians who will work independently at any given time during the project on the structured cabling system shall have a minimum of 3 years' experience on completed telecommunications projects of like magnitude and complexity as to this project. Field technicians working at job site shall have completed a copper technician installation training class conducted by the warranting manufacturer or BICSI.
7. Field technicians who will work independently at any given time during the project on the optical fiber systems shall have a minimum of 3 years' experience on completed telecommunications projects of like magnitude and complexity as to this project. Field technicians working at the job site shall have completed an optical fiber technician installation training class conducted by the warranting manufacturer or BICSI.

#### 1.04 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 260500.
  1. Submit complete at one time. Partial product submittals are not acceptable and will be returned unreviewed.
- B. Pre-Construction Submittal:
  1. Labeling
    - a. Include sample labeling for each of the following telecommunications infrastructure components:
      - 1) Workstation device faceplate identification labeling. Include label per telecommunications room.
      - 2) 110 cross-connect block wall fields for horizontal, intra-building, and inter-building backbone terminations.
      - 3) Surface mount and rack mount fiber cabinets for horizontal, intra-building, and inter-building backbone terminations.
      - 4) Multi-pair copper intra-building and inter-building backbone cabling identification tags.
      - 5) Optical fiber intra-building and inter-building backbone cabling identification tags.
  2. Product Data
    - a. Submit with data arranged under basic categories, such as, certifications, personnel training, manufacturer warranty, products, test equipment and calibration, and similar items. Include index with the submittals.
    - b. Organize by specification infrastructure component sections described in Part 1 and Part 2 of this section.
    - c. Submit Product Data information sheets for coordination with item and model number.
    - d. Where more than one product is indicated on a page, mark product with arrow or by other means to identify exact product or products being submitted by specific part number.
    - e. Submit network test equipment proof of calibration by manufacturer.

f. Submit resumes and certifications of technicians and project manager who will support this project. Certifications shall include:

- 1) Manufacturer's certification to provide warranty
- 2) RCDD certification
- 3) Copper and optical fiber installation certification
- 4) Approved manufacturer classes satisfactorily completed

3. Shop Drawings

- a. Submit Shop Drawings of telecommunications cabling systems.
- b. Coordinate with other trades prior to submittal and start of installation.
- c. Show exact routing of horizontal cabling for workstation distribution throughout building, and intrabuilding and interbuilding copper and optical fiber backbone cabling.
- d. Label workstation devices to identify cabling being terminated in telecommunications rooms and spaces.
- e. Prepare shop drawings using AutoCAD/Revit software or as approved by the Owner. Submit shop drawings full size in PDF format.
  - 1) Project was created in Revit, AutoCAD files shall be extracted from the Revit model by the Contractor.

C. Test Reports:

1. Prepare test reports and submit to the Owner's Representative an electronic copy of the detailed test results, including overall test summary report.
2. Include a copy of the detailed test reports on flash drive in each Operation and Maintenance Manual.
3. Include a hard copy of the summary test sheets in each Operation and Maintenance Manual.
4. Submit electronic copies in PDF and LinkWare software formats, including LinkWare reader software.

D. Record Drawings:

1. Keep complete set of telecommunications drawings in job-site office updated within 3 days to show actual installation of cabling and equipment during construction.
2. Use of this set of drawings for recording as-built conditions.
3. Indicate where material, equipment, and system component are installed differently from that indicated on the Contract Drawings, clearly and neatly using ink or indelible pencil in color red during construction.
4. Prepare electronic set of Record Drawings, incorporating changes during construction. Submit Record Drawings to the Owner's Representative for review and acceptance.
5. Submit Record Drawings using latest version of AutoCAD software or as approved by the Owner, and in PDF format. Request (from architect) final architectural background drawing files that incorporate floor plan and program spaces numbering modifications.
6. AutoCAD drawings shall be e-transmitted to include backgrounds, title blocks and other associated files.
7. Submit electronic copy of Record Drawings in full-size PDF and AutoCAD format, on flash drive.

8. Prepare laminated hard copy of telecommunications floor plan drawings, telecommunications room layouts, and equipment rack elevations. Install in each telecommunications room for associated floor area served.
  - a. Floor plan drawings shall be full-size, scaled down drawings shall not be acceptable.

E. Project Closeout:

1. Submit closeout documentation to the Owner's Representative and Architect under provisions of Division 01, Section 260500 and this section.
2. Provide project closeout documentation including but not limited to; test result documentation, Record Drawings, manufacturer warranty certificates and Operation and Maintenance manuals.

1.05 **DEFINITIONS**

**Accessible ceiling:** An area above acoustical ceiling tiles/grid (or lay-in type ceilings) with a readily accessible space. Gypboard ceilings with access hatches and open to structure spaces shall not be considered accessible ceilings

**Administration:** Methodology defining the documentation requirements of a cabling system and its containment, the labeling of functional elements, and the process by which moves, additions, and changes are recorded

**Bonding:** Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed

**Cable:** An assembly of one or more insulated conductors or optical fibers within an enveloping sheath

**Cable run:** Length of installed media, which may include other components along its path

**Cabling:** System of cables, cords, and connecting hardware

**Channel:** End-to-end transmission path between 2 points at which application-specific equipment is connected including test cords and patch cords for a maximum total distance of 328 feet (100 meters)

**Connecting hardware:** Device, or combination of devices, used to connect cables or cable elements

**Consolidation point:** Location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways

**Cross-connection:** Connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end

**Demarcation point:** Point where operational control or ownership changes

**Equipment room:** Environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect

**Ground:** Conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of earth

**Horizontal cabling:** Distribution media that connects the telecommunications outlet/connector at the work area and the first piece of connecting hardware in the horizontal cross-connect

**Horizontal cross-connect:** Group of connectors that allows equipment and backbone cabling to be cross-connected with patch cords or jumpers

**Infrastructure (telecommunications):** Collection of those telecommunications components, excluding equipment, that together provides basic support for the distribution of information within a building or campus



**Local area network (LAN):** Standard industry term for a network installation that serves a relatively small area (for example, structured cabling installation serving a building)

**Main cross-connect:** Cross-connect normally located in the (main) equipment room for cross-connection and interconnection of entrance cables, first-level backbone cables, and equipment cables

**Metropolitan area network (MAN):** Data communications network that covers an area larger than a campus area and smaller than a wide area network

**Modular jack:** Female telecommunications connector that may be keyed or unkeyed and may have 6 or 8 contact positions

**Outlet/connector (telecommunications):** Connecting device in the work area on which a horizontal cable or outlet cable terminates

**Patch cord:** Length of cable with connectors on both ends used to join telecommunications circuits/links at the cross-connect

**Patch panel:** Connecting hardware system that facilitates cable terminations and cabling administration using patch cords

**Pathway:** Sequence of connections that provides connectivity between devices on a network or between networks on an internetwork; the vertical and horizontal route of the telecommunications cable; a facility for the placement of telecommunications cabling

**Permanent link:** Test configuration for link excluding test cords and patch cords for maximum total distance of 295 feet (90 meters)

**Plenum:** Compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system

**Telecommunications Room:** Enclosed architectural space for housing telecommunications equipment, cable terminations, and cross-connect cabling

**Storage Area Network (SAN):** Specialized high-speed network dedicated to the transport of data between storage devices and servers

**Star topology:** Network topology in which services are distributed from or through a central point

**Telecommunications:** Transmission, emission, and reception of signs, signals, writings, images, and sounds, that is information of any nature by cable, radio, optical, or other electromagnetic systems

**Unshielded twisted pair (UTP):** Cable made up of one or more pairs of twisted copper conductors with no metallic shielding; the entire assembly is covered with an insulating sheath (cable jacket)

**Wireless access point:** Stand-alone hardware device or computer wireless adapter with software that acts as a wireless communication hub for users of wireless devices to connect with each other and to bridge those devices to the cabled portion of the network

**Wide area network (WAN):** Data communications system that uses telecommunications circuits to link LANs that are distributed over large geographic distances

**Wireless local area network (WLAN):** Data communications system that uses using radio frequency technology, such networks transmit and receive data over the air, minimizing the need for wired connections; they combine data connectivity with user mobility

**Work area (workstation):** Building space where occupants interact with telecommunications terminal equipment

**Work area cable (cord):** Cable connecting the telecommunications outlet/connector to the terminal equipment

**1.06 PRE-CONSTRUCTION MEETINGS**

- A. Telecommunications subcontractor shall attend the pre-construction meeting as required by the Contractor or the Owner's Representative.
- B. Provide a schedule, indicating installation tasks, time duration for each task and coordination items to be discussed 5 days prior to the meeting, to the Contractor and to the Owner's Representative. Include milestone dates for network equipment installation and patch cord installation durations.

**1.07 MANUFACTURER CERTIFICATION**

- A. Structured cabling system shall be covered by an Extended Product and Application Assurance Warranty.
  - 1. Warranty shall cover passive telecommunications infrastructure copper and optical fiber connectivity and cabling products and performance from the date of installation registration and will support existing or future applications.
  - 2. Approved manufacturer solution partner and warranty is:
    - a. CommScope Uniprise – 25-year warranty
    - b. Ortronics/Superior Essex (nCompass) – Limited Lifetime warranty
  - 3. Installation practices shall follow the installation guidelines and procedures specified in the manufacturer certified installer training course and current TIA standards.
  - 4. Submit closeout documentation in accordance with the manufacturer warranty requirements to comply for acceptance of warranty.
- B. Provide the original hard copy certificate for the Application Assurance Warranty to the Owner.

**1.08 MATERIAL PROVISIONS**

- A. Deliver materials to the Owner under provisions of this section.
- B. Contractor shall be responsible to provide a material transmittal for all materials being provided to the Owner as described herein and that are not permanently installed. Transmittal shall be signed by the Owner receiving the materials. Transmittal shall be included as part of the O&M manuals.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Substitutions: The substitution of products shall adhere to the requirements defined in Division 01 and this section.
  - 1. Submit requests for substitutions a minimum of 10 days prior to Bid date. Request submitted less than 10 days prior to, shall not be accepted.
  - 2. The basis of design for manufacturer partners is Commscope Uniprise cabling and connectivity as specified herein.

3. Copper connectivity shall be Category 6:
  - a. Pre-approved acceptable alternate manufacturer partners are:
    - 1) Superior Essex Cabling with Ortronics Connectivity.
      - a) Copper: Category 6 NextGain cabling with Ortronics as specified.
4. Optical fiber connectivity shall be OS2 SM:
  - a. Pre-approved acceptable alternate manufacturer partners are:
    - 1) Superior Essex Cabling with Ortronics Connectivity.
      - a) Optical Fiber: OS2 SM with Ortronics as specified.

## 2.02 COPPER HORIZONTAL CABLING

- A. Category 6 UTP cabling for interior spaces:
  1. Horizontal cables shall be constructed from 23 AWG insulated solid bare copper conductors formed into four individually twisted pairs with a crossfiller center spline.
  2. Conductors shall have an impedance of  $100\Omega \pm 10\%$  /100m.
  3. Cables shall meet the most current technical characteristics of TIA-568-C standard.
    - a. Wire map
    - b. Length
    - c. Insertion loss (Attenuation) 32.6dB/100m @ 250MHz
    - d. Near-end crosstalk (NEXT) loss 43.3dB/100m @ 250MHz
    - e. Attenuation to crosstalk ratio far-end (ACRF) 24.8dB/100m @ 250 MHz
    - f. Power sum Attenuation to crosstalk ration far-end (PSACRF) 21.8dB/100m @ 250MHz
    - g. Power sum-near-end crosstalk (PS-NEXT) 41.3dB/100m @ 250MHz
    - h. Return loss (RL) 20.5dB/100m @ 250MHz
    - i. Propagation delay (PD) (CMP) 72% nom, (CMR) 68% nom
    - j. Delay skew (DS) 45ns/100m max
    - k. Balance (LCL/TCL) 27.0dB/100m @ 200MHz
    - l. Balance (EL-TCTL) 9.0dB/100m @ 200MHz
    - m. Cable Jacket Color:
      - 1) Data/voice cabling: Blue
      - 2) Video Surveillance Cabling: Green
  4. Cables shall be UL1666 IEC332-1 CMR (riser) rated as specified herein, unless otherwise noted. Cable diameter shall not exceed 0.23 inches.
    - a. Manufacturer Commscope Uniprise:
      - 1) Blue riser rated, Part No. UN884014904 or approved equal
      - 2) Shielded Green riser rated, Part No. UN884021804 or approved equal

- b. Manufacturer Superior Essex:
  - 1) Blue riser rated, Part No. 66-246-2A
  - 2) Green riser rated, Part No. 6T-246-5A

B. Category 6 UTP outside plant cabling for underground and exterior spaces:

- 1. Horizontal cables shall be constructed from 23 AWG insulated solid bare copper conductors formed into four individually twisted pairs with a crossfiller center spline and enclosed by a UV resistant polyethylene in the color black. Cable shall contain a gel-filled water-resistant flooding compound.
- 2. Cable diameter shall not exceed 0.245 inches.
- 3. Conductors shall have an impedance of  $100\Omega \pm 10\%$  /100m.
- 4. Cables shall meet the most current technical characteristics of TIA-568-C standard.
  - a. Wire map
  - b. Length
  - c. Insertion loss (Attenuation) 32.6dB/100m @ 250MHz
  - d. Near-end crosstalk (NEXT) loss 43.3dB/100m @ 250MHz
  - e. Attenuation to crosstalk ratio far-end crosstalk (ACRF) 24.8dB/100m @ 250 MHz
  - f. Power sum attenuation to crosstalk far-end crosstalk (PSACRF) 21.8dB/100m @ 250MHz
  - g. Power sum-near-end crosstalk (PS-NEXT) 41.3dB/100m @ 250MHz
  - h. Return loss (RL) 20.3dB/100m @ 250MHz
  - i. Propagation delay (PD) 65% nom
  - j. Delay skew (DS) 35ns/100m max
- 5. Cabling shall be utilized per the NEC for use where pathways are routed within or below building slabs and foundations, in outside plant underground pathways and for aerial applications.
  - a. Manufacturer Commscope Uniprise CS340, Part No: UN884019904/10

C. Category 6 UTP UL Listed cabling rated for indoor/outdoor applications:

- 1. Cabling shall be utilized per the NEC for use where pathways are routed within or below building slabs and foundations.
- 2. Horizontal cables shall be constructed from 23 AWG PO (non-plenum) insulated solid bare copper conductors formed into four individually twisted pairs with a core separator.
- 3. Cabling shall be fully water blocked with a flooded core and shall have a black sunlight resistant jacket.
- 4. Cable diameter shall not exceed 0.271 inches.
- 5. Conductors shall have an impedance of  $100\Omega \pm 10\%$  /100m.
- 6. Cables shall meet the most current technical characteristics of TIA-568-C standard.
  - a. Wire map
  - b. Length
  - c. Insertion loss (Attenuation) 32.6dB/100m @ 250MHz
  - d. Near-end crosstalk (NEXT) loss 49/100m @ 250MHz
  - e. Attenuation to crosstalk ratio (ACR) 6.7dB/100m @ 100MHz
  - f. Power sum attenuation to crosstalk ratio (PS-ACR) 4.7dB/100m @ 250MHz

- g. Power sum-near-end crosstalk (PS-NEXT) 40dB/100m @ 250MHz
  - h. Return loss (RL) 17.3dB/100m @ 250MHz
  - i. Delay skew (DS) 25ns/100m max
7. Cabling shall be NEC rated CM for general purpose communications in accordance with Article 800 of the National Electrical Code (NEC.)
- a. Manufacturer Mohawk VersaLAN, Part No. M58772

## 2.03 INTERBUILDING BACKBONE INFRASTRUCTURE

### A. Optical Fiber Cabling – Singlemode:

1. Interbuilding singlemode optical fiber backbone cabling shall be indoor/outdoor rated loose tube cable utilizing a dry water blocking system.
  - a. Singlemode optical fiber shall be Class IVa dispersion-unshifted per EIA/TIA-492CAAB secondary coating diameter of 242  $\mu\text{m}$ . Zero dispersion wavelength shall be between 1300 nm and 1324 nm.
  - b. Nominal mode field diameter shall be 9.2  $\mu\text{m}$  with a tolerance of +/- 0.5  $\mu\text{m}$  at 1310 nm.
  - c. Single-mode optical fiber shall meet the following performance specifications.
    - 1) Maximum Attenuation: 0.4/0.3 dB/km @ 1310/1550 nm
    - 2) Transmission distance: 1 GbE greater than 2 km @ 1310 nm
    - 3) Cutoff Wavelength: <1279 nm when measured in accordance with EIA/TIA-455-170 or EIA/TIA-455-80. Distance versus bandwidth shall be using a laser transmitter operating at a 1310 nm wavelength.
    - 4) Operating Temperature: -40C to +75C
    - 5) Storage Temperature: -40C to +85C
2. Cable shall meet the following standards: ISO/IEC 11801; ICEA S-87-640; Telcordia GR-20; Telcordia GR-409; ICEA S-104-696; ETL and UL OFNR (riser) as specified herein, unless otherwise noted.
  - a. Manufacturer Commscope:
    - 1) 12-strand riser, Part No. R-012-LN-8W-F12BK
    - 2) 24-strand riser, Part No. R-024-LN-8W-F12BK
    - 3) 144-strand riser, Part No. R-144-LN-8W-F12BK
  - b. Manufacturer Superior Essex:
    - 1) 12-strand riser rated, Part No. 130123D01
    - 2) 24-strand riser rated, Part No. 130243D01
    - 3) 144-strand riser rated, Part No. 131443D01

B. Multi-pair Voice Copper Cabling:

1. Interbuilding 100-ohm unshielded twisted-pair backbone cabling shall be constructed with 24 AWG, solid annealed bare copper conductors, insulated with color coded solid polyolefin. All cable pairs shall be twisted, and core assemblies shall consist of 25-pair units. The core assembly shall be filled with an 80°C ETPR (Extended Thermoplastic Rubber) compound, completely filling the interstices between the pairs and under the core wrap. The core wrap shall be a non-hygroscopic dielectric tape. Shielding shall be corrugated, copolymer coated, .008-inch aluminum tape. Shielding shall be grounded and bonded to the ground system at each termination end. Cable shall be black low-density polyethylene material and marked with appropriate identifications.
2. Cables shall meet the electrical requirements of 100-ohm, backbone cabling as specified in TIA-568-C.
  - a. Manufacturer Superior Essex, Sealpic-F series cable:
    - 1) 6-pair, Part No. 04-092-21
    - 2) 12-pair, Part No. 04-094-21
    - 3) 25-pair, Part No. 04-097-21
    - 4) 50-pair, Part No. 04-100-21
    - 5) 100-pair, Part No. 04-104-21
    - 6) 200-pair, Part No. 04-108-21
    - 7) 300-pair, Part No. 04-110-21

C. Multi-pair Category 5 Copper Cabling:

1. Interbuilding 100-ohm unshielded twisted-pair backbone cabling shall be constructed with 24 AWG, solid annealed bare copper conductors, insulated with color coded solid polyolefin. All cable pairs shall be twisted, and core assemblies shall consist of 25-pair units. The core assembly shall be filled with an 80°C ETPR (Extended Thermoplastic Rubber) compound, completely filling the interstices between the pairs and under the core wrap. The core wrap shall be a non-hygroscopic dielectric tape. Shielding shall be corrugated, copolymer coated, .008-inch aluminum tape. Shielding shall be grounded and bonded to the ground system at each termination end. Jacket shall be black low-density polyethylene material and marked with appropriate identifications.
2. Cables shall meet the electrical requirements of 100-ohm, backbone cabling as specified in TIA-568-C.
  - a. Manufacturer Superior Essex, MEGAPIC series:
    - 1) 12-pair, Part No. 04-094-31
    - 2) 25-pair, Part No. 04-097-31

D. Entrance Protection Blocks:

1. Primary protection for interbuilding copper backbone cabling shall be at service entrance facilities as indicated on the Contract Drawings. Primary protection shall be multi-pair protector panel providing protection for circuits exposed to voltage surges and sneak currents, terminals shall be gold-plated, 110-type connector in and 110-type connector out, cables to feed from either top or bottom input entrance and utilizing individual 5-pin plug-in type protector units. Protector panel shall be UL Listed, and REA approved. Entrance facility protector shall utilize in the splice chamber of the protector, a No. 6 ground strap, with eyelet for connection to the shield of the OSP cable and connected to the protector grounding network.
  - a. Manufacturer Circa:
    - 1) 6-pair, Part No. 1880ENA1/NSC-6
    - 2) 12-pair, Part No. 1880ENA1/NSC-12
    - 3) 25-pair, Part No. 1880ENA1/NSC-25
    - 4) 50-pair, Part No. 1880ENA1/NSC-50
    - 5) 100-pair, Part No. 1880ENA1/NSC-100
  - b. Plug-in type protector units shall be gas and solid-state types, molded to glass-reinforced, high-heat-distortion plastic (polybutylene terephthalate), line pins shall be gold-plated and ground pins solder-plated. One protector unit is required for each terminated pair of cable used.
    - 1) Manufacturer Circa:
      - a) POTS Line applications
      - b) Gas-tube with current limiter, Part No. 4B1E
      - c) Data Line applications (i.e. RS-232)
      - d) Solid-state, Part No. 3B1FS-240
      - e) Analog or Digital Voice Line applications
      - f) Solid-state with sneak current protection, Part No. 4B1FS-240
2. Primary protection for horizontal copper cabling shall be at service entrance facilities as indicated on the Contract Drawings when Category 5e or Category 6 4-pair UTP cabling is utilized for outdoor applications for protection of exposed circuits to voltage surges and sneak currents. Splitting of cable pairs between two different protector units is prohibited. Termination style shall be 110-type connector in and 110-type connector out. Housing shall be metallic and UL Listed and REA approved. Entrance facility protector shall be grounded with a #6 AWG.
  - a. Manufacturer Circa:
    - 1) 6-pair indoor, Part No. 1880ENA1/NSC-6e
    - 2) 12-pair indoor, Part No. 1880ENA1/NSC-12e
    - 3) 25-pair indoor, Part No. 1880ENA1/NSC-25e

- b. Plug-in type protector units shall be rated to support digital lines, Voice-Over-IP connections and provide network protection for 1-Gigabit Ethernet applications. Modules shall be rated for 75 volts. One protector unit is required for each terminated pair of cable used.
  - a) Supports standard PoE at 15.4W only (will not support PoE+)
  - 2) Manufacturer Circa, Part No. 4B6S-75e
- E. Cable Shield Bonding Connector
  - 1. Connector shall always contain a spring top plate to remain in contact with the shield. Connector shall penetrate the polymer coating on the cable shield to provide excellent pull-out strength and electrical contact.
    - a. Manufacturer Preformed, Part No. 8000751 or equal
- F. Splice Closures:
  - 1. Copper splice closures shall be pressure tight, 2-Type closure "kit" containing all components for a complete assembly and system. System shall facilitate the re-entry of closure assembly, be reusable, and be resistant to outside contaminants. Cover assembly shall include channel bars and bolts, splice wrap and cable ties, R-type self-forming gasket material, solvent cleaner, back cover support clips with cable ties, pressurization valve, internal shield continuity braid with insulation, external grounding ribbon, and ground connectors with hex nuts. End plate assembly shall include end plate with sheath grip clamps, cable collar and end plate R-type self-forming gasket material, solvent cleaner, cable diameter measuring tape, shielded connector, cable sheath scuff, hose clamps, sheath grip clamps, and slotted washers for sealing cable entrances.
    - a. Manufacturer 3M:
      - 1) Covers:
        - a) Sheath opening 600-pairs max fill, Part No. 2A2AA
        - b) Sheath opening 600-pairs max fill, Part No. 2A2A
        - c) Sheath opening 1200-pairs max fill, Part No. 2B2AA
        - d) Sheath opening 1200-pairs max fill, Part No. 2B2A
        - e) Sheath opening 1800-pairs max fill, Part No. 2C2AA
        - f) Sheath opening 1800-pairs max fill, Part No. 2C2A
      - 2) Endplate (cable entrance and exit, 2-endplates required per cover):
        - a) One 2.2" opening, Part No. 2A2-1E
        - b) Two 2.2" openings, Part No. 2B2-2E
        - c) One 2.8", two 1.6" openings, Part No. 2C2-3E
      - 3) **Note:** Differing applications based on varying pair-counts shall dictate the use of other cover and end plate kit part numbers from those noted above. Consult Contract Drawings and Project Engineer before proceeding.



2. Optical fiber closures shall be a "kit" containing all components for a complete assembly and system. System shall facilitate the re-entry of closure assembly, be reusable, and be resistant to outside contaminants. Splice closure shall be hermetically sealed. Provide additional grommets as required to maintain seal.
  - a. Manufacturer Preformed:
    - 1) Coyote In-Line RUNT, Part No. 8006951
    - 2) 12-count splice tray (fusion), Part No. 80807701
    - 3) Wall mount bracket, Part No. 8003703

#### 2.04 INNERDUCT AND CABLE IDENTIFICATION TAGS

##### A. Textile Innerduct:

1. Textile innerduct shall contain multiple flexible, polyester/nylon textile resin polymer fabric textile cells per innerduct as indicated on the Contract Drawings. Innerducts shall be installed within conduit raceways. Innerduct cells shall be the color white and shall have footage markers indicated on the side of the cell.
2. Center spine of textile innerduct shall be installed in the color black or red when utilizing a 3-inch width. Black shall be the default color when only one set of innerduct is being installed within a conduit. Center spine of textile innerduct shall be installed in the color purple when utilizing a 2-inch width.
3. Cells within the textile innerduct shall contain a pull tape in differentiating colors. One cell shall have a pull tape in the color white, a second cell shall have a pull tape in the color white with a blue stripe and the third cell shall have a pull tape in the color white with an orange stripe.
  - a. Manufacturer MaxCell:
    - 1) 2-inch, 2 cell with the color black spine, Part No. MXE52222BKyyyy (yyyy = length in feet)
    - 2) 3-inch, 3 cell with the color black spine, Part No. MXE64283BKyyyy (yyyy = length in feet)
    - 3) 3-inch, 3 cell with the color red spine, Part No. MXC64283RDyyyy (yyyy = length in feet)
4. Textile innerduct installation kits shall be provided for a single innerduct pack or multiple innerduct packs. Utilize an 1800 lbs. swivel device or a 2-way/3-way chain harness based upon the quantity of innerducts being installed within a conduit raceway.
  - a. Manufacturer MaxCell:
    - 1) Single 1800 lbs. swivel, Part No. MXCSW600
    - 2) 2-Way chain pulling harness, Part No. MXC2CH
    - 3) 3-Way chain pulling harness, Part No. MXC3CH

5. Textile innerduct inflation termination bags shall be provided for each conduit. Inflation bags shall be provided in each outside plant conduit at the last maintenance hole that routes to either the associated telecommunications room or the exterior junction box on the building or structure. Inflation bags shall also be provided at the opposite end at the telecommunications room or the exterior junction box.

- a. Manufacturer MaxCell:

- 1) 4-inch diameter Inflation Bag, Part No. MXCRTBVL100
- 2) 3-inch diameter Inflation Bag, Part No. MXCRTBVL80
- 3) 2-inch diameter Inflation Bag, Part No. MXCRTBVL50

- B. Copper and Optical Fiber Identification Tags:

1. Identification tags shall be self-laminating, write-on, rigid, non-adhesive, measuring 3.50" x 2.00", and with a vinyl material strength of 0.20". Attach the tags to the associated innerduct or directly to the cabling utilizing specified cable ties. The legend and nomenclature for optical fiber cabling shall read "CAUTION: FIBER OPTIC CABLE" and for copper cabling shall read "CAUTION: TELEPHONE CABLE". Each tag shall have sub attribute lines for "TYPE" and "COUNT". The tag color for optical fiber cabling shall be yellow and the tag color copper cabling shall be orange.

- a. Manufacturer ACP International:

- 1) Optical fiber cabling tags, Part No. VCT-200 (yellow)
- 2) Copper cabling tags, Part No. VCT-201 (orange)

2. Cable tie shall be dome-top; barb type with stainless steel locking barb, material shall be Nylon 6.6 with a maximum width of .141".

- a. Manufacturer Panduit or equal:

- 1) 6.1-inch length, Part No. BT1.5I-C0
- 2) 8.0-inch length, Part No. BT2I-C0

## 2.05 TELECOMMUNICATIONS WORKSTATION DEVICES

- A. Category 6 Modules:

1. 8-Position 8-Conductor modules shall be Category 6, dual reactance technology, non-keyed, universal T568A/B pin configuration standard and used to terminate Category 6 UTP cables as specified herein. Module shall be high impact plastic housing, flame retardant UL 94V-0, modular contacts shall be beryllium copper, nickel plating under 50 micro-inches gold plating in contact area. IDC contacts shall be phosphor bronze, nickel under plating with tin lead over plate serving 22 through 24 AWG.

- a. Manufacturer Commscope:

- 1) Category 6 module:
  - a) Blue (Data/Voice), Part No. UKJ600-BL
  - b) Black (Wireless), Part No. UKJ600-BK

- 2) Shielded Category 6 Module (for IP Cameras and Intercoms):
  - a) Green, Part No. USL600-SHLD-GN
- 3) Blank module in package of 25:
  - a) White, Part No. 1-1116412-3

B. Faceplates:

1. Faceplate shall be manufactured to hold 8P8C modules with recessed designation strips with clear plastic covers in accordance with the TIA-606-B labeling standard.
2. Color shall be Black in public Spaces, White in private spaces. Coordinate color with Owner and Architect.
  - a. Manufacturer Commscope:
    - 1) 2-port thermoplastic:
      - a) Black, Part No. FP-LBL-2P-003
      - b) White, Part No. FP-LBL-2P-262
    - 2) 4-port thermoplastic:
      - a) Black, Part No. FP-LBL-4P-003
      - b) White, Part No. FP-LBL-4P-262
    - 3) 6-port thermoplastic:
      - a) Black, Part No. FP-LBL-6P-003
      - b) White, Part No. FP-LBL-6P-262

C. Surface Mount Boxes:

1. Surface mount boxes shall be thermoplastic to hold 8P8C modules with recessed designation strips with clear plastic covers in accordance with the TIA-606-B labeling standard. Surface mount boxes shall meet UL2043 for plenum applications.
  - a. Manufacturer Ortronics:
    - 1) 1-Port white, Part No. SMB-1P-266
    - 2) 2-Port white, Part No. SMB-2P-KJ-266

D. Identification Icons:

1. Voice icons shall be in the color white. Provide owner bag of 100.
2. Data icons shall be blue.
3. Wireless access point and IP camera data icons shall be yellow.
4. Icons shall be mounted on each 8P8C modular jack.
  - a. Manufacturer Commscope:
    - 1) Part No. 1-1375092-0

- E. Power Pole Bezel:
1. Bezel shall hold 8P8C modules and shall utilize a 106-type configuration.
  2. Bezel shall be a color that matches the power pole; default color shall be Wiremold Ivory.
    - a. Manufacturer Ortronics, Part No. 40800019-99

## 2.06 DIRECT CONNECT AND ALARM CONNECTIVITY

### A. Direct Connect Connectivity and Terminations:

1. 8P8C Modular Plugs
  - a. Pre-approved Category 6 8-position, 8-conductor 8P8C plugs shall be provided based on the warranting manufacturer for the direct attach termination to solid conductor Category 6 cabling.
  - b. 8P8C plugs shall be compatible to be terminated on both Category 6 and Augmented Category 6 cabling.
  - c. 8P8C plugs shall be field terminated with manufacturer approved termination tool. No other termination tools shall be authorized for the termination of these direct attach terminations.
  - d. Plugs with a plastic boot shall be plenum rated when used in an air-plenum environment.
  - e. Adhere to manufacturer's plug installation guidelines and testing procedures to ensure proper performance and signal transmission.
    - 1) Category 6 8P8C plug approved manufacturers:
      - a) Bel Stewart, Part No. SS-39100-021
      - b) Sentinel, Part No. 111-08080054L34
      - c) Allen Tel, Part No. AT8X8RCSC-24
    - 2) 8P8C termination tool approved manufacturers:
      - a) Bel Stewart, Part No. 2990003-01
      - b) Sentinel, tool & die set, Part No. 9000015 & 900216
      - c) Allen Tel, Part No. AT568 or AT680

## 2.07 TELECOMMUNICATIONS ROOM SUPPORT EQUIPMENT

### A. Fire Retardant Plywood Backboards:

1. Plywood backboards shall be 3/4" fire retardant ACX plywood to cover the walls as indicated in the Contract Drawings. Backboard shall bear a seal identifying the plywood is fire retardant. Backboard shall be painted white with the seal left exposed for permanent identification.

### B. Ladder Rack:

1. Ladder rack as specified herein shall be installed within the telecommunications room only. See Section 260536 for cable trays located outside for the telecommunications room.

2. Ladder rack shall be prefabricated metal structure consisting of longitudinal stringer side rails with cross members welded at 12-inch intervals on center.
3. Both stringer side rails and cross members shall be constructed of 3/8-inch x 1-1/2-inch x 0.065-inch wall rectangular steel tubing. No portion of the cross-member rungs shall protrude below the bottom or above the top plane of the side rails.
4. Additional hardware required to construct the designed runway shall be those recommended by the manufacturer. Mounting supports shall be based upon the building conditions of the space. Utilize wall or ceiling/structural support mounting methods only, ladder rack shall not be attached to or supported by the equipment rack. Provide seismic bracing of the ladder rack as required by the AHJ. Cable loading shall meet the loading requirements of NEMA 12C.
  - a. Manufacturer CPI:
    - 1) Universal cable runway, Part No. 10250-7xx (xx = width of ladder rack)
    - 2) Cable runway radius bends:
      - a) 90-degree outside vertical bend, Part No.10723-7xx (xx = width of ladder rack)
      - b) 90-degree inside vertical bend, Part No. 10724-7xx (xx = width of ladder rack)
      - c) E-bend, Part No. 10822-7xx (xx = width of ladder rack)
    - 3) Cable runway corner bracket, 15-inch, Part No. 11959-715
    - 4) Cable runway corner bracket, 24-inch, Part No. 11959-724
    - 5) Cable retaining posts, 6-inch, Part No. 10596-706
    - 6) Protective end caps, 1-pair, Part No. 10642-001
5. Vertical wall brackets shall be provided within 12-inches of each end of the cable runway and spaced at a maximum of 5-feet apart.
  - a. Manufacturer CPI, Part No. 10608-701
6. Wall angle support kits shall be provided where cable runway terminates perpendicular to the wall. Wall angle support kits consist of one wall angle bracket, two j-bolts and attachment hardware.
  - a. Manufacturer CPI, Part No. 11421-7xx (xx = width of ladder rack)
7. Triangular bracket support kits shall provide wall support for ladder tray. Supports shall be constructed of 1/4" x 2" aluminum bar and have a load rating of 100 lbs. Supports kits shall consist of one triangular bracket, j-bolts and attachment hardware.
  - a. Manufacturer CPI:
    - 1) Ladder rack width 4-6 inches, Part No. 11312-706
    - 2) Ladder rack width 6-12 inches, Part No. 11312-712
    - 3) Ladder rack width 12-18 inches, Part No. 11312-718

8. [Steel-heavy duty] Triangular bracket support kits shall provide wall support for ladder tray. Supports shall be constructed of cold rolled steel and have a load rating of 400 lbs. Supports kits shall consist of one triangular bracket, j-bolts and attachment hardware.
  - a. Manufacturer CPI:
    - 1) Ladder rack width 9-18 inches, Part No. 11746-718
    - 2) Ladder rack width 9-24 inches, Part No. 11746-724
      - a) [Specify -724 with 18" ladder for 6" off wall]
9. Threaded ceiling kits shall be provided where cable runway runs parallel to the wall and above equipment racks at intervals not to exceed 5-feet. Ceiling kits consists of one ceiling support bracket, one 5/8-inch x 6-foot-long threaded rod, one runway support bracket and four 5/8-inch hex nuts. Provide (2) kits at each support location.
  - a. Manufacturer CPI:
    - 1) Threaded ceiling kit, 1 kit, Part No. 11310-003
    - 2) For locations where the ceiling height exceeds the 6-foot threaded rod length, provide 5/8-inch threaded rod coupling kit and 5/8-inch threaded rod.
      - a) Threaded rod coupling kit, Part No. 10697-002
      - b) Threaded rod, 5/8-inch x 12-feet, Part No. 11440-004
      - c) Threaded rod, 5/8-inch x 8-feet, Part No. 11440-005
      - d) Threaded rod, 5/8-inch x 4-feet, Part No. 11440-006
10. Radius drop out brackets shall be provided at all sections along the ladder rack where cabling enters and exits the horizontal pathway. Movable cross members shall be provide for radius drops where fixed rungs are not positioned directly over the side channels of the equipment rack.
  - a. Manufacturer CPI:
    - 1) Cross member radius drops, Part No. 12100-7xx (xx = width of ladder rack)
    - 2) Stringer radius drops, Part No. 12101-711
    - 3) Movable cross member cable runway, Part No. 12115-7xx (xx = width of ladder rack)
11. Splice kits shall be utilized to connect sections in accordance with manufacturer's recommendations.
  - a. Manufacturer CPI:
    - 1) Butt-splice kit, Part No. 11301-701
    - 2) Junction-splice kit, Part No. 11302-701
    - 3) 45-degree runway splice kit, Part No. 11313-701

12. Ground straps shall be provided to bond cable runway sections at butt and junction splice points. Ground strap kit consists of 8-inches of #6AWG green insulated wire attached at both ends to two-hole compression lugs and attachment hardware. The cable runway shall be bonded to the telecommunications grounding and bonding system.
    - a. Manufacturer CPI, Part No. 40164-001
  13. Elevation kits shall be installed above racks or cabinets to provide additional space between the tops of the racks or cabinets and the ladder rack for radius drop fittings and maintaining cable bend radius at transitions from horizontal to vertical.
    - a. Manufacturer CPI:
      - 1) Rack elevation kit, 4-6 inches, Part No. 10506-706
      - 2) Rack to runway plate, 9-12 inches, Part No. 10595-712
      - 3) Rack to runway plate, 15-18 inches, Part No. 10595-718
      - 4) Cabinet elevation kit, 4-6 inches, Part No. 10506-716
    - b. Manufacturer Ortronics:
      - 1) Two-inch high rack elevation kit for perpendicular ladder rack.
        - a) 6.5-inch-deep rack, Part No. MM20CRB06-B
        - b) 10.5-inch-deep rack, Part No. MM20CRB10-B
        - c) 16.25-inch-deep rack, Part No. MM20CRB16-B
      - 2) Six-inch high rack elevation kit for perpendicular ladder rack.
        - a) 6.5-inch-deep rack, Part No. MM20CRB6H06-B
        - b) 10.5-inch-deep rack, Part No. MM20CRB6H10-B
        - c) 16.25-inch-deep rack, Part No. MM20CRB6H16-B
- C. Wall Mounted Cable Management
1. 110 Jumper Troughs shall have with legs and be mounted above and below each 100-pair or 300-pair 110 wiring block kit.
    - a. Manufacturer Ortronics, Part No. 30200140
  2. Flexible D-rings shall be provided for routing and managing cabling on backboards.
    - a. Manufacturer Panduit, Part No. CMVDR2

## 2.08 TELECOMMUNICATIONS ROOM GROUNDING AND BONDING

- A. Telecommunications Main Grounding Busbar (TMGB):
1. TMGB shall be a copper plate, 1/4" thick x 4" wide x 20" long conforming to BICSI and TIA standards.
  2. TMGB shall be pre-drilled for bolts to secure bar to insulating standoffs. Mounting holes shall be 3/8" diameter spaced 5.75" apart. TMGB shall include insulators to isolate busbars from the wall or other mounting surfaces.

3. Busbar shall be pre-drilled with hole pattern to accommodate two-hole lugs as follows, (27) lugs with 5/8" hole centers and (3) lugs, 1" hole centers.
  - a. Manufacturer CPI, Part No. 40153-020
- B. Telecommunications Grounding Busbar (TGB):
  1. TGB shall be a copper plate, 1/4" thick x 4" wide x 10" long conforming to BICSI and TIA standards.
  2. TGB shall be pre-drilled for bolts to secure bar to insulating standoffs. Mounting holes shall be 3/8" diameter spaced 5.75" apart. TGB shall include insulators to isolate busbars from the wall or other mounting surfaces.
  3. Busbar shall be pre-drilled with hole pattern to accommodate two-hole lugs as follows, (4) lugs with 5/8" hole centers and (3) lugs, 1" hole centers.
    - a. Manufacturer CPI, Part No. 13622-010
- C. Telecommunications Bonding Backbone (TBB):
  1. Telecommunications Bonding Backbone conductors shall be 3/0 AWG stranded insulated copper conductor, unless otherwise noted.
- D. Pipe Clamps:
  1. Copper UL listed grounding connector with pre-drilled lug pad allowing 2-hold compression terminal; the size of connector will be dictated by pipe size.
    - a. Manufacturer Burndy, T&B, Thermoweld or approved equal.
- E. Communication Grounding Rods:
  1. Copper-clad steel, 5/8" x 9' long.
    - a. Manufacturer Burndy, T&B, Thermoweld or approved equal.
- F. Exothermic Welding:
  1. Manufacturer Erico Cadweld or Thermoweld, appropriate fittings as required.
- G. C-type Compression Taps:
  1. Bonding together two or more bonding backbones.
    - a. Manufacturer Burndy, T&B, Thermoweld or approved equal.
- H. Cable Terminals:
  1. Cable terminal shall be two-hole, non-insulated copper compression long barrel terminal, requiring 3/8" bolts on 1" and 5/8" centers.
    - a. Manufacturer Burndy, T&B, Thermoweld or approved equal.



2.09 EQUIPMENT RACKS AND CABLE MANAGEMENT

A. 2-Post Free-Standing Equipment Racks:

1. Standard Channel Equipment Racks

- a. Equipment racks shall have 2.5-inch channel with standard EIA mounting hole pattern.
- b. Equipment racks shall be 7'-0" high with 45 rack units of mounting space.
- c. Equipment rack side rails shall have manufactured rack unit labeling on each side of the rails.

- 1) Manufacturer CPI, Part No. 46353-703

B. 4-Post Free-Standing Equipment Racks:

1. 4-Post Equipment Racks

- a. Equipment racks shall have front and rear 3-inch channel spaced 29 inches apart with standard EIA mounting hole pattern.
- b. Equipment racks shall be 7'-0" high with 45 rack units of mounting space and 2000 lbs. loading capacity.
- c. Equipment rack side rails shall have manufactured rack unit labeling on each side of the rails.

- 1) Manufacturer CPI, Part No. 50120-703

C. Peripheral Devices for Equipment Racks:

1. Equipment racks shall be equipped with the following. Quantities shall be provided as indicated on the Contract Drawings.

a. Manufacturer CPI:

- 1) 19-inch wide equipment shelf, Part No. 40074-700
- 2) 19-inch wide heavy-duty double sided, Part No. 11164-719
- 3) Monitor shelf, Part No. 11245-719
- 4) Full size keyboard and mouse tray, Part No. 12193-701
- 5) Equipment mounting screws, package of 50, Part No. 40605-005

2. Equipment racks shall be anchored with a 1/2-inch anchor design for concrete and shall include (4) 1/2-inch anchors, (4) 3-3/4-inch long bolts, (4) washers and (4) nuts.

- a. Manufacturer CPI, Part No. 40604-003 or approved equal

D. Rack Mount Cable Management:

1. Horizontal cable management panels shall distribution rings to secure coper and/or optical fiber patch cords.

a. Manufacturer CPI:

- 1) 1RU panel with cover, Part No. 13930-701
- 2) 2RU panel with cover, Part No. 13930-702

- 3) 2RU panel with 6-inch rings, Part No. 11564-719
2. Vertical cable management panels shall be 7'-0" high and have latches spaced 12 inches apart for securing cabling and patch cords to be provided in between and at the end of each equipment rack as indicated on the Contract Drawings.
    - a. Manufacturer CPI:
      - 1) 3.65-inch wide double sided, Part No. 12096-703
      - 2) 6-inch wide double sided, Part No. 11729-703
  3. Vertical cable management panels shall be 7'-0" high and have a hinged solid covered door on the front and back securing cabling and patch cords to be provided in between and at the end of each equipment rack as indicated on the Contract Drawings.
    - a. Manufacturer CPI:
      - 1) 6-inch wide double sided, Part No. 40098-703
      - 2) 10-inch wide double sided, Part No. 40099-703
      - 3) 12-inch wide double sided, Part No. 40100-703
- E. Wall Mount Enclosure:
1. Enclosure shall be hinged style wall mountable with dimensions of 24 inches width and 30 inches depth and shall be capable of supporting up to 300 lbs. of equipment.
  2. Rear panel shall be 5-inch deep and shall provide cable access with pre-punched knockouts for conduit along the top and bottom edges of the panel. There shall be (4) combination 3/4-inch conduit knockouts (2 top/2 bottom), (4) combination 2-1/2-inch conduit knockouts (2 top/2 bottom) and 9-inch x 2.2-inch knockout.
  3. Enclosure shall have two adjustable #12-24 tapped EIA mounting rails and shall provide mounting space for 19-inch equipment.
  4. Enclosure shall contain grilled sides for ventilation and keyed locking mechanism on the front door and side hinge for security.
  5. Enclosure shall have a tinted tempered glass front door.
    - a. Manufacturer CPI:
      - 1) 12RU 24 inches high Part No: 12419-724
      - 2) 18RU 36 inches high, Part No. 12419-736
      - 3) 26RU 48 inches high, Part No. 12419-748
      - 4) Dual fan/filter kit (pair), Part No. 40975-001
      - 5) Cable port brush kit (pair), Part No. 25190-000
      - 6) Vertical cabling section (pair), 7RU, Part No. 40970-707
      - 7) Vertical cabling section (pair), 11RU, Part No. 40970-711
- F. Wall Mount Enclosure – Vertical:
1. Enclosure shall be 36 inches high, 26 inches wide and 12 inches deep with fully adjustable mounting rails. Enclosure shall contain grilled sides for ventilation and keyed locking mechanism for security.
    - a. Manufacturer CPI, Part No. 13050-723

G. Flush-Mount Wall Bracket:

1. Flush-Mounted Wall Bracket shall support rack-mounted equipment, vertically, and flush to a wall, supporting up to 150 lbs. Bracket shall have square-punched mounting rails and include a pack of 25 Clik-Nut equipment mounting hardware.
  - a. Manufacturer CPI:
    - 1) 3U, Part No. 11583-719
    - 2) 6U, Part No. 11754-719

2.10 SERVER ENCLOSURES

A. Server Enclosure:

1. Enclosure shall be EIA-standard 7 feet high x 27.6 inches wide x 43.30 inches deep, designed specifically for rack mounted servers. Each enclosure will have 2 pairs of mounting channels with alternating square hole pattern for cage nuts to adapt to M6, 10-32, or 12-24 server mounting screws.
2. Enclosure weight capacity shall be a minimum of 2500 lbs., complete with two top angles, two base angles, two horizontal braces, self-supporting bases, top and bottom expansion pans, and top panel shall be two-piece server-style with four cabling access openings.
3. Enclosures shall have two pairs of sliding continuously adjustable equipment mounting rails to provide front and rear support to network and server equipment with cage nuts. Rack mount units (U) shall be 1-3/4" high and shall be marked and numbered on the mounting rails. Numbering shall start at the bottom of the rail. Mounting rails shall provide 45U for equipment.
4. Front door shall be single sided with perforated screening. Rear door shall be double sided with left and right hand hinged with perforated screening. Enclosure shall include locking hardware on the front and rear doors.
5. Dedicated and independent keyed locking mechanisms shall be provided on the doors for each network user group as indicated on the Contract Drawings.
  - a. Manufacturer CPI F-Series TeraFrame Gen 3 System, Part No. FF2N-113B-C42-B

2.11 POWER DISTRIBUTION

A. Vertical Power Strips:

1. Equipment racks shall be equipped with the following. Quantities shall be provided as indicated on the Contract Drawings.
  - a. Vertical power strip shall be 24" vertically mounted with (14) NEMA 5-20 receptacles.
    - 1) Manufacturer Ortronics:
      - a) NEMA 5-20 plug, Part No. LP-21100
      - b) NEMA L5-20 plug, Part No. LP-21200
      - c) PDU bracket, Part No. MM20PDUMBFT2W-B

B. Horizontal Power Strip:

1. Equipment racks shall be equipped with the following. Quantities shall be provided as indicated on the Contract Drawings.
  - a. Horizontal power strip shall be one rack unit in height with (10) NEMA 5-20 receptacles.
    - 1) Manufacturer Ortronics:
      - a) NEMA 5-20 plug, Part No. LP-21110
      - b) NEMA L5-20 plug, Part No. LP-21210

C. Vertical Power Strips:

1. Equipment racks shall be equipped with the following. Quantities shall be provided as indicated on the Contract Drawings.
  - a. Vertical power strip shall be a 33-inch vertically mounted power strip with (14) NEMA 5-20 receptacles and NEMA 5-20 plug.
    - 1) Manufacturer CPI:
      - a) Power strip, Part No. 12850-705
      - b) 9.1-inch mounting bracket, Part No. 35700-701 (per power strip)

D. Horizontal Power Strip:

1. Equipment racks shall be equipped with the following. Quantities shall be provided as indicated on the Contract Drawings.
  - a. Horizontal power strip shall be one rack unit in height with (8) NEMA 5-20 receptacles and NEMA 5-20 plug.
    - 1) Manufacturer CPI, Part No. 12816-705

2.12 TELECOMMUNICATIONS ROOM CONNECTIVITY

A. Patch Panels:

1. Category 6 Modular Patch Panels
  - a. Category 6, 8-Position 8-Conductor module, non-keyed, dual reactance technology, 110 type printed circuit board style patch panels, universal T568A/B pin configuration standard and used to terminate UTP cables as specified herein. Patch panels shall be high density, 6-port modules, panel thickness at .125" aluminum with black powder coat finish; module shall be high impact plastic housing, flame retardant UL 94V-0, and fully encased protected printed circuitry. Modular contacts shall be beryllium copper, nickel under plating, 50 micro-inches of gold in contact area with IDC contacts phosphor bronze, nickel under plating with tin lead over plate, serving 22 through 24 AWG.

- 1) Manufacturer Commscope:
  - a) 24 port patch panel, Part No. UNP-6-DM-1U-24
  - b) 48 port patch panel, Part No. UNP-6-DM-2U-48

B. Optical Fiber Cabinets and Adapter Panels:

1. Optical fiber cabinet shall be a termination and administration point for the optical fiber cables. Cabinets shall protect the connectorized optical fiber from mechanical stress, macro-bending loss at the connection point and tampering with the circuits.
2. Rack Mount Fiber Cabinets (RMFC)
  - a. RMFC shall accommodate terminating and splicing capabilities for optical fiber strands.
  - b. RMFC shall be stackable, rack mountable depending on the location requirement. The cabinets shall be one, two or four rack units in height.
  - c. RMFC shall consist of an enclosure with front and rear access and can be fully administered from the front or rear.
  - d. RMFC shall have a hinged door in the front with removable top panels and solid rear door.

- 1) Manufacturer Commscope:
  - a) 1RU patching and splicing, Part No. EPX-1U-MOD-ENC-FX
  - b) 2RU patching and splicing, Part No. EPX-2U-MOD-ENC-FX
  - c) 4RU patching and splicing, Part No. EPX-4U-MOD-ENC-FX

e. Fusion Splice Trays

- 1) Fiber splice trays shall be offered with clear polycarbonate covers for viewing, and tie-down holes for securing incoming fiber. The trays shall accommodate heat-shrink style splicing for both single-mode and multimode fiber.
  - a) Manufacturer Commscope, Part No. EPX-SPLICE-TRAYS

3. Optical Fiber Adapter Panels

- a. Optical fiber adapter panels shall be located within surface mount and rack mount fiber cabinets. Panels shall securely lock into open positions with the patching frames. Panels shall have plunger /grommet fasteners.
- b. Optical fiber adapter panels shall consist of ST, LC or SC connector types and shall be configured in either simplex or duplex connector arrangements and indicated in the Contract Drawings.
- c. Unfilled positions within the fiber cabinets shall contain blank panels.

- 1) Manufacturer Commscope:
  - a) Blank adapter panel, Part No. OFP-BLANK

- d. Singlemode optical fiber connectors shall be in the color blue with ceramic alignment sleeves.
  - 1) Manufacturer Commscope:
    - a) 6-Duplex LC SM, Part No. PNL-BK-012-SFA-LC02-BL-NS

## 2.13 OPTICAL FIBER CONNECTIVITY

### A. Optical Fiber Fan Out Kits

- 1. Buffer tube fan-out kits shall provide the means of field-install connectors on 250  $\mu$ m coated fibers. Indoor kits shall have a 900  $\mu$ m fan-out assembly that is color coded to match the fiber color scheme. The fan-out assembly shall be 47-inches in length.
  - a. Manufacturer Corning:
    - 1) 6-fiber kit, Part No. FAN-BT47-06
    - 2) 12-fiber kit, Part No. FAN-BT47-12

### B. Fusion Splice Sleeves

- 1. Fusion splice sleeves shall provide protection for fusion splices in rack mount and surface mount fiber cabinets. Sleeves shall be heat-shrink style in 60mm length.
  - a. Manufacturer Corning, Part No. 2806031-01 (Qty. 50)

### C. Singlemode Connectors with Pigtails

- 1. Singlemode pigtail cabling assemblies shall be provided for splicing to optical fiber cables for interconnecting into fiber adapter panels. Pigtails shall be constructed in a simplex form.
- 2. Pigtails shall be fusion spliced when terminating optical fiber cabling to rack mount and surface mount fiber cabinets.
- 3. Singlemode connectors that are straight tip shall be identified with the color blue.
  - a. Manufacturer Corning:
    - 1) LC, Part No. 000201R4131003M

### D. Singlemode Connectors

- 1. Field installable singlemode connectors shall be provided to terminate optical fiber cables from cable-to-cable, cable-to-equipment, or equipment-to-equipment. Singlemode connector shall contain a factory bonded fiber strand insert, ceramic ferrule and factory polished.
- 2. Connector shall be capable of mounting on 125-micron fiber. The connector shall meet IEC standards for repeatability and have a locking feature to the coupler and assure non-optical disconnect.
- 3. Singlemode connectors that are straight tip shall be identified with blue.

4. Angled polished connectors shall be identified with green.
  - a. Manufacturer Commscope:
    - 1) LC, Part No. SFC-LCF-09-8Y-12-PACK
  - b. Manufacturer Corning:
    - 1) LC, Part No. 95-200-96

#### 2.14 OPEN CABLING SUPPORTS

- A. Accessories and mounting hardware shall be provided for securing supports to structure for a complete and working installation of open cabling supports. Supports shall comply with TIA requirements for structured cabling systems and pathway supports. Follow manufacturer's recommendations for quantity of cables supported.
- B. Hook & Loop Fasteners:
  1. Hook and loop fastener rolls shall be 0.5-inch in width. Shear strength for plenum hook and loop fasteners shall be 29 PSI. Hook and loop fasteners installed in plenum air spaces shall be UL Listed (plenum) and be in the color maroon.
    - a. Manufacturer Leviton, plenum, Part No. 43115-75P or equal
  2. Hook and loop fastener rolls shall be 0.5-inch in width. Shear strength for non-plenum hook and loop fasteners shall be 23 PSI.
    - a. Manufacturer Leviton, non-plenum, Part No. 43115-75 or equal
- C. Circular Cable Retainer:
  1. Cable retainers shall be of plastic material with rounded edges, plenum rated, utilizing an easy-lock closure and an attachment base. Cable retainers shall be screwed into structure and only be utilized in spaces that are extremely tight and J-hooks do not have sufficient space to be mounted.
    - a. Manufacturer Erico Caddy, Part No. CAT CR50
- D. J-Hooks:
  1. J-hooks shall have a Galvanized finish with rounded edges for smoother cable pull and greater corrosion resistance.
    - a. Manufacturer Erico Caddy:
      - 1) 1" Dia., Part No. CAT16HP
      - 2) 1-5/16" Dia., Part No. CAT21HP
      - 3) 2" Dia., Part No. CAT32HP

- E. Adjustable Cable Support:
1. Adjustable cable supports shall be of steel and polyethylene, plenum rated, with unlocking and locking bar allowing additional cables to be added easily after installation.
    - a. Manufacturer Erico Caddy, Part No. CAT425
- F. Conduit Waterfalls:
1. Waterfalls shall be of glass reinforced flame-retardant nylon 6.6 and UL Listed for air handling spaces (plenum).
  2. Waterfalls shall be provided at the ends of 4-inch conduits and conduit sleeves installed horizontally where the pathways transition from conduit to ladder rack and cable tray pathways. Waterfalls shall be utilized to provide bend radius of all horizontal and backbone cabling.
    - a. Manufacturer Panduit, Part No. CWF400

## 2.15 FIRE-RATED PATHWAYS

- A. Fire-rated pathway device shall consist of a corrugated steel tube with zinc coating, contain an inner plastic housing, intumescent material rings and tightly twisted inner fabric smoke seal. Intumescent firestopping material shall automatically adjust to the size of the cabling bundle and shall permit cabling to be added or removed without the need to remove the firestopping material through the adjustment of the flanges and device threads at the ends of each sleeve. After the installation of the cabling, twist the inner fabric smoke seal so that it seals around the cabling. Length of the sleeve shall be 12.4 inches. The pathway device shall be UL tested and classified in accordance with ASTM E814 (UL1479).
1. Manufacturer HILTI Speed Sleeve:
    - a. 2-Inch fire-rated pathway device, Part. No. 2097882
    - b. 4-Inch fire-rated pathway device, Part No. 2097883
- B. Fire-rated pathway device shall consist of a heavy gauge galvanized steel raceway lined with intumescent firestopping material. The intumescent firestopping material shall automatically adjust to the size of the cabling bundle and shall permit cabling to be added or removed without the need to remove the firestopping material. Provide the necessary quantity of wall plates to support the pathway device. The pathway device shall be UL tested and classified in accordance with ASTM E814 (UL1479).
1. On the 3-inch and 4-inch sleeves, provide radius control modules at the end of each sleeve through wall transitions and penetrations.
    - a. Manufacturer Specified Technologies, Inc. EZ Path:
      - 1) 1.5-Inch fire-rated pathway device, Part No. EZD22
      - 2) 3-Inch fire-rated pathway device, Part. No. EZDP33FWS
      - 3) 3-Inch radius control module, Part No. RCM33
      - 4) 4-Inch fire-rated pathway device, Part No. EZDP44S2
      - 5) 4-Inch radius control module, Part No. EZRCM44S
      - 6) 4-Inch extension module, Part No. EZD44ES



- C. Firestopping putty shall be a one-part, two-stage intumescent, non-hardening compound. The putty, when exposed to high heat or flame shall be capable of expanding a minimum of five times. Range of continuing expansion shall be from 230 °F to >1,000 °F (110 °C to >538 °C). The putty shall be soft and pliable with aggressive adhesion and shall not contain any water-soluble intumescent ingredients. The putty shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).
1. Manufacturer Specified Technologies, Inc. SpecSeal:
    - a. 24" putty bar, Part No. SSP28
    - b. 36" putty bar, Part No. SSP100

## 2.16 MATERIAL PROVISIONS

- A. Materials shall be provided to the Owner as specified herein. Deliver to the Owner Representative 21 days prior to Substantial Completion. Include a signed transmittal to the Owner or Owner's Representative for each type of patch cord, quantity, length, and color provided as part of the Final Acceptance.
1. Copper Patch Cords
    - a. Category 6 Patch Cords
      - 1) Patch cords shall be constructed from Category 6 4-pair 24 AWG, stranded patch cable material.
      - 2) Patch cord cable assembly shall be UL→ listed and meet FCC Part 65 plug and termination.
      - 3) Provide the following patch cable quantities and lengths to the Owner. Verify all lengths with authorized representative prior to procurement.
        - a) 10ft. workstation cords for 100% of the wireless access point faceplates.
        - b) 10ft. workstation cords for 75% of the installed faceplates.
        - c) 6ft. patch cords for 50% of the installed faceplates.
        - d) 4ft. patch cords for 25% of the installed faceplates.
        - e) 3ft. patch cords for 100% of the installed faceplates.
      - 4) 3. Provide the following colors:
        - a) White – Workstation/Data Rack Patch
        - b) Yellow – Voice Rack Patch
        - c) Black – Wireless
      - 5) Manufacturer Commscope:
        - a) Series No: C0166S2
    2. Optical Fiber Patch Cords
      - a. Singlemode Patch Cords (OS2)
        - 1) Optical fiber patch cords shall be 9/125 μm with ceramic ferrules, constructed from OFNR rated dual fiber cordage, in the color yellow.

- 2) Provide as needed. Coordinate with Owner.
- 3) Manufacturer Commscope:
  - a) Part No. FEWLCLC42 Series

PART 3 - EXECUTION

3.01 **ADDITIONAL CABLING**

- A. Provide an additional (24) Category 6 and (12) Category 6A cables to be located during construction by the Owner. Workstation devices shall be as specified herein including but not limited to; cabling, faceplates, modules, blank modules, open cabling supports, labeling and testing.
  - 1. Assume an installed cable length of 295'.

3.02 **GENERAL**

- A. Include labor, materials, tools, equipment, and services for installation as indicated on the Contract Documents.
- B. Coordinate Work with other trades for complete and operational system.
- C. Include supplementary and miscellaneous items, appurtenances, and devices incidental to and necessary for sound, secure, and complete installation, whether specifically indicated in the Contract Documents.
- D. Provide suitable barriers and take any other safety precautions required by applicable codes.
- E. Work area shall be kept free from debris of all types and remove all rubbish resulting from their work on the premises. Upon completion, vacuum and clean room floors, equipment racks, enclosures and cable management where work has been performed.
- F. Contractor shall be responsible for any building repairs made necessary by their work or caused by negligence of their employees. No cutting, notching, drilling or altering of any kind shall be done to the building without first obtaining permission from the Owner.
- G. Owner may have other contracts in connection with this work for the installation of software and equipment. Contractor shall provide other Trade Contractors reasonable opportunity for the introduction and execution of their work and shall properly coordinate other trade's work with theirs as required.
- H. Provide patch panels and blocks indicated on the telecommunications drawings whether they are fully populated with cables.
- I. Provide cables, devices and equipment racking systems as indicated on the Contract Drawings.

**3.03 ABANDONED CABLING**

- A. Telecommunications cabling and infrastructure shall include but not limited to, faceplates, surface mount boxes, RJ11 and 8P8C modules, horizontal UTP cabling, copper and optical fiber backbone infrastructure, innerduct, cabling support systems, equipment racks, horizontal and vertical cable management, equipment shelving, ladder tray, dedicated telecommunications surface raceway, 110 and 66 blocks, rack mount and surface mount fiber cabinets and other related passive infrastructure.
- B. Contractor shall salvage telecommunications equipment racks, patch panels, horizontal and vertical cable management and optical fiber connectivity being demolished. These items shall be returned to the Owner unless directed by the Owner to be disposed of by the contractor. All other telecommunications passive infrastructure shall be disposed of by the contractor.
- C. Provide blank cover plates for demolished flush mount outlets, surface mount boxes, modular furniture feed locations, and junction boxes.
- D. Provide blank cover plate for demolished modular furniture telecommunications devices. Match modular furniture manufacturer system, make and base channel color.
- E. Provide new cover plates for surface mount raceway systems after demolition of existing devices. Cover plate sections shall be seamless between new devices. Cover plates shall match existing base color.
- F. Provide fire stopping of existing horizontal and vertical conduit sleeve, after existing horizontal and backbone cabling has been demolished. Provide fire stopping of existing wall penetrations. Seal all penetrations with approved fire stopping materials.
- G. Provide (2) pull strings in each vertical conduit riser sleeves at the completion of demolition of existing cabling.

**3.04 TELECOMMUNICATIONS ROOM EQUIPMENT INSTALLATION**

- A. Primary function of a telecommunications room is the termination of horizontal, backbone and service entrance cabling to compatible connecting hardware.
- B. Telecommunications room also provides a controlled environment to house telecommunications equipment, connecting hardware, and splice enclosures serving a portion of the building.
- C. Install fire retardant plywood backboard vertically at 6" AFF painted with white latex paint as indicated on drawings. Backboard shall be painted to leave fire seal exposed. See Contract Drawings for location of backboards in the telecommunications rooms and spaces.
- D. Provide equipment including the following, but not limited to the following, and shall be installed according to the Contract Drawings:
  - 1. Equipment racks and enclosures with cable management systems
  - 2. Cross-connect patch panels and termination blocks, whether they are populated or not.
  - 3. Telecommunications workstation devices
  - 4. Cable tray and ladder rack

- E. Where applicable, each freestanding equipment rack and/or server enclosure shall be seismically braced from the top to a structural component beam, column, bearing wall, etc. of the building. AHJ shall determine if seismic bracing is required and if structural engineering services are required.
- F. Equipment rack shall be secured to the concrete floor with a concrete floor mounting kit.
- G. Contractor shall be responsible to provide the rack mounting of the UPS and shall provide the activation and commission for each UPS within each telecommunications room and space.
- H. 110 blocks shall be securely fastened to the backboards in the telecommunications room. Provide all required D-rings or other approved cable guides as identified on the Contract Drawings.

### 3.05 DEMARCATION EXTENSION CROSS-CONNECTS

- A. Contractor shall be responsible for coordinating and providing the voice and data network cross-connects at the building service entrance facility with the Owner if not provided by the Local Exchange Carrier. Provide labeling and identification of voice and data network circuits including transmit and receive pairs.

### 3.06 LADDER RACK INSTALLATION

- A. Install ladder rack at locations indicated on the drawings. Installation shall be in accordance with manufacturer's instructions and with recognized industry practices to ensure that ladder rack equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.
- B. Support the ladder rack on 5-foot centers for a total of 2 supports for every 10-foot span when the ladder rack is supported from the ceiling. Support ladder rack at every transition. Support ladder rack utilizing wall mount brackets or ceiling support bracket hangers. Threaded rod supports exceeding 60 inches in length shall be provided with rod stiffeners utilizing C-channel strut.
- C. Provide additional brackets on ends, and two additional brackets at tees and corners. Securely fasten ladder rack to brackets and supports using clamps manufactured for the purpose. Provide all required hardware and supports.
- D. Fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions.

### 3.07 OPEN CABLING SUPPORT INSTALLATION

- A. Cabling shall be run exposed as "open cabling" in accessible ceiling spaces and accessible ceiling plenums, unless otherwise noted. Where ceiling spaces are inaccessible or open to structure cabling shall be routed in conduit.
- B. Provide all hanger supports and cable supports for cabling specified in this section. All support structures shall adhere to the requirements in the National Electrical Code.
- C. Cabling supports shall be spaced no further than 4'-0" apart.
- D. Cabling bundles shall not sag a maximum of 2-inches from the bottom of the cable support.

- E. Provide all additional cable management products as required to protect exposed cabling and complete the installation of cabling in a neat professional manner.
- F. Floor penetrations shall be at columns, exterior walls unless otherwise specified.
- G. Cabling supports shall be installed on their own support system. The use of ceiling grid supports shall be prohibited.
- H. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit or other system supports. Cabling shall never come in physical contact with these mechanical, fire protection and electrical systems and raceways.
- I. Cabling bundles and supports changing pathway direction shall maintain proper bend radius as to not impact the physical jacket construction of the cabling. Cabling that becomes damaged during this transition shall be replaced in its entirety.
- J. Follow manufacturer's recommendations for quantity of cables supported in J-hooks and adjustable cable supports.
- K. Installers shall observe the applicable requirements and recommended good practices contained within TIA-568-C standard for cabling installation requirements.

### 3.08 CABLING INSTALLATION

- A. Telecommunications devices shall be connected to the horizontal cross-connect in a telecommunications room with horizontal cabling installed in star topology.
- B. Horizontal cabling shall be installed in continuous runs from the telecommunications rooms to telecommunications device locations. Splices are not permitted.
- C. Maximum length of horizontal cables shall be 295 feet (90 m) including all service loops.
- D. Cabling shall be installed in accordance with manufacturer's recommendations, including but not limited to maximum tensile loading and maximum bend radius.
- E. Cabling shall be organized and identified to facilitate locating and handling individual sheaths for maintenance functions.
- F. Bundles shall be neatly secured without cinching or stressing the cabling, using hook and loop fasteners in open cabling installations and in the telecommunications room. Hook and loop fasteners shall be loose enough so that the fastener can be easily rotated around the cabling bundle and does not impact the physical construction of the cabling.
- G. Provide machine typed label on both ends of the horizontal cabling jacket no more than 4-inches from each termination point.
- H. Great care shall be taken to protect all cabling from physical damage beneath floors, above ceilings or elsewhere. Cabling shall not be exposed to any forces or handling factors that will degrade performance, such as crushing, pull stressing, twisting, or damaging sheathing materials. When left unattended, all cabling shall be secured and protected to avoid damage.
- I. Hook and loops fasteners shall be utilized in the telecommunications room for all cabling bundles. Tie wraps are prohibited in the telecommunications rooms and spaces.

- J. A spare pull string shall be installed at every outlet installed.
- K. Horizontal and backbone cabling shall be bundled and routed separately in dedicated cabling supports in a neat and organized fashion for routing from the telecommunications rooms utilizing cable trays and open cabling pathways to the telecommunications devices.
- L. Route cabling runs from workstations parallel to building grid lines and directly to open cabling pathways without passing over adjacent office spaces or cubicles.
- M. Provide 5 feet of slack in neatly suspended loops above each workstation and 10 feet of slack neatly coiled in the ladder rack or cable tray in the telecommunications room unless indicated otherwise on Contract Drawings. Service loops in the telecommunications room shall not be located above the equipment racks and server enclosures.
- N. [Seattle PS]Provide 12 inches of slack in neatly suspended loops above each workstation and 10 feet of slack neatly coiled in the ladder rack or cable tray in the telecommunications room unless indicated otherwise on Contract Drawings. Service loops in the telecommunications room shall not be located above the equipment racks and server enclosures.
- O. Provide 20-foot service loop for optical fiber and multi-pair copper backbone cables. Backbone service loops shall be attached to the fire-retardant plywood backboard and shall not be located on the ladder rack or cable tray.
- P. Cables shall contact only dedicated and properly protected cable accesses and support mechanisms.
- Q. Telecommunications unshielded twisted pair cabling supported utilizing open cabling methods shall maintain a minimum separation of three inches from fire alarm, intercom/paging, clocks, and security cabling. Cabling supports shall maintain increased separation requirements when attaching to the same hanger rod to ensure cabling sag maintains the minimum three-inch separation.
- R. Maintain the following distances between cabling and other building systems:
  - 1. One foot from fluorescent lights.
  - 2. Six feet from motors and transformers.
  - 3. Three feet from water piping or other mechanical equipment.
  - 4. One foot from electrical conduits or other electrical equipment.

### 3.09 CONNECTIVITY AND CABLING INSTALLATION

- A. Cabling shall be dressed and terminated in accordance with the cabling installation requirements identified in TIA-568-C, BICSI Telecommunication Cabling Installation Manual, and the manufacturer's documentation.
- B. Cabling entering the telecommunications room and routing on the ladder rack or cable tray pathway shall be separated into cabling bundles specific to the patch panel in which it will be terminated to. Cable bundles shall be in increments of 24 cables.
- C. Cabling 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 equipment rack, enclosure, or backboard.

- D. Cabling transitioning from ladder rack or cable tray pathway shall maintain proper bend radius utilizing waterfall device brackets for transitioning vertically down the side rail of an equipment rack or server enclosure as to not impact the physical jacket construction of the cable. Waterfall device brackets shall also be utilized for transitioning cabling to blocks mounted on plywood. Cabling that become damaged during this transition shall be replaced in their entirety.
- E. Cabling shall terminate from one side of each patch panel only. The cabling shall terminate from the alternate side for the next patch panel position below the previous patch panel termination and shall continue in this orientation for the entire duration of the number rack units per equipment rack.
- F. Cables shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support straps. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.
- G. Installation of 8-position 8-conductor modular jacks into faceplates and attaching of the faceplates to the wall shall ensure that the faceplates are flush. The faceplate shall be secured to the wall but shall not be secured to the wall with such force as to bow the faceplate.

### 3.10 WORK AREA

- A. 4-pair UTP horizontal cabling shall be terminated on an 8-position 8-conductor modular jack or plug at each telecommunications device as indicated on the applicable Contract Drawings.
- B. Telecommunications devices shall be provided with 8-position 8-conductor modular jacks or plugs in the quantity as indicated on the applicable Contract Drawings.

### 3.11 CABLING TERMINATIONS

- A. Provide all necessary installation materials, tools and equipment to perform insulation displacement type terminations at all the telecommunications outlets, patch panels and 110 cross-connect blocks.
- B. Pairs in each cable shall be terminated on a 110 block, modular patch panel or telecommunications modules in accordance with this specification.
- C. Cabling shall be terminated in accordance with the T568B pin configuration standard.
- D. Remove only as much of the cable sheath as is necessary to terminate the cabling on the connecting hardware.
- E. A maximum of 0.25" of cable pair twists shall be removed from a 4-pair UTP cable. Cabling and terminations exceed these dimensions shall be re-terminated.
- F. At the horizontal station patch panel, the cabling shall terminate from the center of the 110 IDC termination.
- G. Terminate cabling in accordance with connecting hardware manufacturer's recommendations. All cabling shall terminate in numerical sequence.

### 3.12 FIRESTOPPING

- A. Firestop systems shall be installed in accordance with the NEC and the manufacturer's recommendations and shall be accomplished in a manner acceptable to the local fire and building authorities having jurisdiction over this work.
- B. Cabling running through rated floors and walls shall be firestopped in accordance with the requirements within this Section.
- C. Penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure).
- D. Penetrations created by or for the contractor and left unused shall also be sealed as part of the contractor's scope of work.
- E. Firestop putty or pillows shall be used inside conduits and cable trays to provide a re-enterable system allowing telecommunications cables to be easily removed or added in the future. Firestop putty shall not be water soluble.
- F. Firestop systems shall be UL Classified to ASTM E814 (UL 1479).
- G. Firestopping sleeved devices shall be installed according to the manufacturer's recommendations including, but not limited to;
  - 1. Wiring devices shall be installed in locations where indicated on the Contract Drawings, arranged in a single or multiple sleeve formation at the height specified. Sleeves shall be installed a minimum of 6 inches above the accessible ceiling grid.
  - 2. Install the devices in strict accordance with the approved shop drawings and the manufacturer's recommendations.
  - 3. Apply the factory supplied gasket material prior to the installation of the wall plates.
  - 4. Secure wall plates to devices per the equipment manufacturer's recommendations.

### 3.13 TELECOMMUNICATIONS GROUNDING AND BONDING

- A. Grounding and bonding connections to the building's structural steel, electrical service main building ground and telecommunications bonding backbone shall be terminated on the left side of the busbar to facilitate access for other grounding sources within the space to be terminated within the center and right side of the busbar.
- B. Bonding backbone shall route along the shortest and straightest pathway as possible with minimal bends. Any bend shall be sweeping. The conductors shall be continuous and shall not contain splices.
- C. Telecommunications bonding backbone shall connect the main telecommunications grounding busbar to each other telecommunications grounding busbar within the facility.
- D. Grounding and bonding conductor distances shall meet the distance requirements described within TIA-607-C.
- E. Grounding and bonding connections shall be a stranded, insulated copper conductor with a minimum size of #6 AWG.



- F. Grounding and bonding connectors shall be 2-hole and made with a crimp or other non-reversible termination method.
- G. Provide a coupled bonding conductor for outside plant copper shielded cabling routing between buildings and ground to the busbar.
- H. Provide grounding and bonding of each building entrance protection block.
- I. Provide a dedicated grounding connection for the below floor and overhead ladder rack and/or cable tray pathways.
- J. Equipment racks and server enclosures shall have a dedicated grounding connection.
- K. Provide grounding and bonding of all telecommunications pathways including conduit raceway systems and ladder rack pathways.
- L. Ensure that all grounding and bonding connections break through and/or remove the paint to the bare metallic surface of all painted metallic hardware.
- M. Coordinate with the flooring contractor to ensure that the grounding strip located below the anti-static dissipative vinyl composition tile flooring is located and terminated directly below the busbar to minimize the distance of the required grounding conductor.

#### 3.14 INSTALLATION OF TEXTILE INNERDUCT

- A. Flexible textile innerduct shall be installed in compliance per manufacturer written instructions.
- B. Utilize manufacturer required installation swivels and harnesses.
- C. Tie off innerduct spines and pull strings within each maintenance hole on the side racking and just below the ladder rack or cable tray within the telecommunications rooms. Provide a separate tie off device mounted securely to the plywood backboard in the telecommunications room. Utilizing the overhead ladder rack or cable tray is prohibited as a tie off connection for the innerduct.
- D. Maintain innerduct color code identification schemes and cable tie labeling throughout the entire outside plant duct bank pathway system.
- E. Cells shall have a specific color and identification tag label, where the cell is a spare or has cabling installed within.
- F. Ensure the innerduct does not spiral during installation. Innerduct shall be hand guided from the reel, maintenance hole openings and into the assigned underground conduit.
- G. Provide inflatable installation kits for water and moisture blocking for conduits where the innerduct has been installed within the service entrance maintenance hole, service entrance exterior junction box and telecommunications rooms.
- H. Pull strings shall be maintained unused in spare innerduct cells.

3.15 **INSTALLATION OF OPTICAL FIBER CABLING SYSTEM**

- A. Installation for Optical Fiber Cabling:
1. Follow cable manufacturer's specifications regarding handling methods, bend radius and maximum pulling tension limitations.
- B. Securing Fiber Cabling:
1. Immediately after cabling installation, a permanent identification tag as indicated shall be attached to visible cabling sections. Cabling shall be checked to ensure that the markings are intact.
  2. Cabling and equipment shall be supported and secured as indicated. Where the specific method of support is not indicated, supports and fasteners shall be used to secure cabling and equipment in position. Metallic supports and fasteners shall have a corrosion resistant finish. All cabling shall be routed along the interior sides of manholes.
  3. Corrosion resistant clamps and straps shall be used as necessary to properly secure the cabling.
  4. Optical fiber cabling shall be secured to the optical fiber cabinet using the aramid strength yarn of the cabling to provide strain relief.
- C. Optical Fiber Cabling Bending:
1. Caution shall be used when bending cabling to avoid kinks or other damage to the sheath. Bend radius shall be as large as possible with a minimum of 20 times the cabling diameter. Minimum radius shall be increased when necessary to meet cable manufacturer's recommendation. Cabling shall not rest against any sharp edges.
- D. Optical Fiber Cabling Pulling:
1. Pulling lines shall be attached to both cable ends when cabling is destined for bi-directional pull and fitted with factory-installed pulling eyes where possible. Cabling not equipped with a pulling eye shall have the pulling line attached to the cable end by means of a cable grip. Core hitches shall not be used.
  2. Cable reels shall be located and aligned so that the cable is payed out from the top of the reel by rotating the reel in the feed direction at the rate of pull into the duct or conduit in a long, smooth bend without twisting. Cabling shall not be payed out from the bottom of the reel or by pulling. A cable feeder guide of proper dimensions shall be used at the mouth to guide the cable into the duct or conduit.
  3. Rigging shall be set up at the pulling end so that the pulling line and cable exit on a line parallel with the duct or conduit to prevent either from rubbing against the edge or mouth. Cable ends shall not be pulled around sheave wheels. When the sheave or pulley cannot be positioned to obtain sufficient cable end slack for proper racking and splicing with the pulling line attached to the end of the cable, a split cable grip may be used to obtain the necessary slack.
  4. Equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Cabling shall be payed out without stopping until the required amount of the cabling has been placed. If the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cabling shall be overcome by increasing the tension in small steps a few seconds apart until the cabling is in motion.
  5. Pulling tension shall not exceed 500 lbs. or cable manufacturer's recommendation, whichever is less.

6. Provide a 20' foot service loop for all optical fiber cabling located at both ends of the cabling run in all telecommunications rooms and in utility vaults. Service loop shall be attached to the fire-retardant plywood backboard and shall not be located on the ladder rack or cable tray.
  7. Do not pull optical fiber cables with copper cables.
  8. Do not pull optical fiber cables over existing cables.
  9. When pulling optical fiber cabling in an innerduct or conduit, do not exceed the 40% fill ratio.
- E. Optical Fiber Cabling Terminations:
1. Cable terminations shall be made in optical fiber distribution units. All installed optical fiber strands shall be terminated.
  2. Optical fiber cabling terminations shall utilize enclosures and components in quantities consistent with the required fiber counts at each end of each segment. During optical fiber connector termination and polishing, visually inspect all terminations with a 400-power microscope. Follow all of the connector manufacturer's recommendations. Unacceptable flaws in the terminations will include, but not limited to, scratches, full or partial cracks, bubbles, pits, epoxy residual, dirt, dust, oil, moisture, grinding and sanding debris. The acceptable final polish will show a connector tip that is free of all imperfections in 100% of the core and 80% of the cladding. All unacceptable connectors shall be inspected after rework.
  3. Optical fiber cabling slack shall be neatly coiled within the optical fiber cabinet. No slack loops shall be allowed external to the optical fiber cabinet.
  4. Cables shall be clearly labeled at the entrance to the fiber adapter panel.
  5. To maintain the correct polarity throughout the optical fiber cabling system, each cabling segment shall be installed in a pair-wise crossover orientation as defined in TIA 568-C.
  6. Dust caps shall be installed on the connectors and couplings.
- F. Optical Fiber Mechanical Splices and Trays:
1. Adhesive mechanical splices shall follow the manufacturer assembly process including stripping, cleaving, and inserting fibers, securing by invoking cam. Optical fiber strands shall be tuned during the assembly process insuring a low loss splice and mounted into optical fiber trays.
  2. Optical fiber trays shall be mounted in surface and rack mount fiber cabinets, enclosures, and equipment racks, maintaining bend radius and in providing protection for optical fiber strands.
- G. Bonding and Grounding Interlocking Armored Cable:
1. Bond interlocking armored optical fiber cable to the telecommunications grounding system.
  2. A dedicated, UL listed #6 AWG stranded copper insulated bonding conductor shall be attached to the interlocking armor using a NEC approved clamp, lug or connector. Apply vinyl tape around the clamp, lug or connector and exposed armor to protect the installer and the optical fiber from any sharp edges where the armor is exposed.
  3. Bond the other end of the bonding conductor to the Telecommunications Main Grounding Busbar (TMGB) or the Telecommunications Grounding Busbar (TGB) or a metallic enclosure bonded to a NEC recognized grounding system.

4. Bond and grounding of optical fiber cable interlocking armor shall be in compliance with the NEC and with the cabling and connectors/clamp manufacturers' installation instructions.

### 3.16 LABELING

#### A. General:

1. Labeling shall be in accordance with TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure.
2. Labels shall be permanent typewritten labels produced by a labeling machine.
3. Labels shall be installed on all cabling at each end. Ensure labels are securely fastened.
4. Labels shall be located within 6 inches of cable termination and placed so they can be easily read.
5. Font type for each type of label shall be Arial with maximum size font allowed.
6. Labeling information will be reviewed at the Pre-Construction Meeting.
7. Labeling shall be completed prior to the Substantial Completion date of the project.

#### B. Telecommunications Device Labeling:

1. Label shall be produced to fit into the recess provided and covered with a clear plastic cover.
2. NOTE: Labeling scheme shall be used for a tenant space with a single or multiple telecommunications rooms:
  - a. TR-2-03-04 where:
    - 1) TR = Telecommunications Room (MC, IC, HC or as indicated on the Contract Drawings)
    - 2) -2 = Equipment rack number
    - 3) -03 = Patch panel number
    - 4) -04 = Port number
3. NOTE: Labeling scheme shall be used for a tenant space within a campus environment:
  - a. ##-TR1A-2-03-04 where:
    - 1) ## = Building number
    - 2) TR = Telecommunications Room (MC, IC, HC or as indicated on the Contract Drawings)
      - a) TR(1) = Floor Number
      - b) TR1(A) = Telecommunications room where multiple TRs exist on a floor. Letter designation shall occur from West to East for the locations of the TR.
    - 3) -2 = Equipment rack number
    - 4) -03 = Patch panel number
    - 5) -04 = Port number

4. Above Ceiling Device Labeling:
  - a. A label on the ceiling grid shall be provided at each location where a network device is located above the ceiling. The label shall be machine generated. The text shall be in bold white letters on black background printed on 3/4" tape with the maximum font size allowable.
  - b. Labeling shall be as follows:
    - 1) 'WAP' - TR-2-03-04 where:
      - a) WAP = Device type as indicated on the Contract Drawings
      - b) TR-2-03-04 = Cable ID Label

C. Equipment Rack Labeling:

1. Plastic lamacoid nameplate shall be provided for each equipment rack and/or server enclosure in the telecommunications room.
2. Plastic lamacoid nameplate shall be black with white letters. The nameplate shall be machine engraved with a size 36 font.
3. Mount the name plate at the top of each equipment rack, server enclosure or wall mount enclosure.
4. Labeling scheme shall be as indicated on the Contract Drawings.

D. Patch Panel Labeling:

1. Station Patch Panel
  - a. 48-port modular patch panels shall be labeled with sequential numbering starting with "01" for the topmost patch panel and moving downward to the bottom of the rack. Patch panel labels shall be affixed to the left-hand side of the patch panel.
  - b. Horizontal cabling distributed from station patch panels to specialty devices (i.e., wireless access points, security devices and IP intercom speaker digital clocks) shall have a label in the designation strip space directly below the 8P8C module identifying the device interconnect point, the designation label shall be as follows:
    - 1) "WAP - #", where the "#" represents the Owner's wireless access point identification number.
    - 2) "CAM - #", where the "#" represents the Owner's security video camera identification number.
    - 3) "AC - #", where the "#" represents the Owner's IP Access Control identification number.
    - 4) "IC- #", where the "#" represents the Owner's IP Intercom Clock room/space per the architectural floor plans.
    - 5) "AV - #", where the "#" represents the Owner's IP Audio Visual Controller room/space identification number.

E. Demarcation Extension Labeling:

1. Extension of service provider demarcation points shall be labeled as indicated on the Contract Drawings and as described herein.

2. 66 blocks, patch panels, and surface mount interface boxes shall be labeled with the service provider and circuit identifiers at both the service entrance facility and the telecommunications room.
3. Demarcation extension cable shall be labeled at both ends identifying the circuit type extended. Circuit types shall be identified with labels reading "T1", "T3", "ISDN", "DS3" and "Analog".

F. Rack Mount Fiber Cabinet Labeling:

1. RMFC shall be labeled with sequential numbering starting with "FC1" for the topmost fiber cabinet and moving downward to the bottom of the rack. Labels shall be affixed to the left-hand side of the RMFC.

G. Optical Fiber Connector Panel Labeling:

1. Labeling shall be placed within the designation strip holder of the fiber connector panel where designation strips are provided with the connector panel.
2. Labeling shall be placed on the inside of the front door for surface mount fiber cabinets and rack mount fiber cabinets where no designation label strips are provided. The label shall be in the same orientation of the connector panel.
3. Labeling shall contain the originating telecommunications room designation, rack row if applicable, equipment rack number designation, rack mount fiber cabinet number, fiber adapter panel position(s) and the associated fiber strand numbers by individual strands and/or optical fiber subunit classification.
4. Main Cross-connect will have labeling associated for the distribution of optical fiber cabling to each telecommunications room and the telecommunications room (IC or HC) will have labeling associated from the Main Cross-connect.
5. Backbone Optical Fiber Labeling:

- 1) NOTE: Labeling for larger projects, where multiple RMFC's are located in the MDF room

b. Labeling shall be as follows in the originating telecommunications room:

- 1) HC1.1.FC1.A:1-6 where:

- a) HC1 = telecommunications room
- b) .1 = Equipment rack number
- c) .FC1 = Rack mount fiber cabinet number
- d) .A = Connector panel position
- e) :1-6 = Strand numbers per connector panel

c. Labeling shall be as follows in the originating telecommunications room:

- 1) MC.1.FC1.A:1-6 where:

- a) MC = Telecommunications room
- b) .1 = Equipment rack number
- c) .FC1 = Rack mount fiber cabinet number
- d) .A = Connector panel position
- e) :1-6 = Strand numbers per connector panel
- f)

- H. Cable Identification Tag Labeling:
1. Optical fiber and copper backbone cabling shall be clearly and visibly identified by the contractor in all manholes, pull boxes, riser room pull points, entrance points, service entrance and 3' before entering a free-standing rack, wall mounted enclosure or surface mount fiber cabinet utilizing an optical fiber cable identification tag.
  2. Optical fiber and copper backbone cable identification tags shall contain the following information at a minimum.
    - a. Cable manufacturer and part number
    - b. Extent of cable run (i.e., "From: MC - To: HC1A")
    - c. Cable type and description (i.e., "In/Outdoor Loose Tube, OM3 12-strand")

### 3.17 TESTING

- A. Test procedures shall be as prescribed by the TIA, Insulated Cable Engineers Association and the National Electrical Testing Association.
- B. Test Equipment:
1. Network testing equipment shall be a Fluke Networks DSX-5000 Cable Analyzer or equal and shall have a certified calibration from the manufacturer within the past 12 months at the time of testing. Proof of calibration shall be provided with the product submittal. Test equipment shall be utilized to test horizontal and backbone cabling.
  2. Field tester and adapters shall be certified by an independent laboratory as meeting or exceeding current level as defined in TIA-1152 Level IIIe.
  3. 8P8C test plug for the network testing equipment adapters shall be in range of values defined in Annex C with TIA-568-C for Near-end Crosstalk, Far-end Crosstalk and Return Loss.
  4. Test equipment shall support the complete suite of Resistance Unbalanced standards for PoE per IEEE 802.3af, IEEE 802.3at and TIA-568-C.2.
  5. Test equipment shall be able to test up to a 1000 MHz frequency range.
  6. Test equipment shall be ISO 9001 certified.
  7. An electronic copy of the manufacturer's testing procedures shall be kept in the job site office.
  8. Test equipment batteries shall be charged daily and a level of greater than twenty-five percent of capacity shall be maintained during the testing.
  9. Test equipment shall be calibrated daily before the start of testing.
- C. Horizontal Cabling:
1. Horizontal cabling shall be certified to meet or exceed the permanent link performance specifications for Augmented Category 6 horizontal cabling tested with a frequency range from 1MHz to 500 MHz as defined in TIA-568-C.
  2. Horizontal cabling shall be certified to meet or exceed the permanent link performance specifications for Category 6 horizontal cabling tested with a frequency range from 1MHz to 250 MHz as defined in TIA-568-C.
  3. Certifications shall include the following parameters for each pair of each cable installed:
    - a. Building identification
    - b. Cable identification
    - c. Date of test
    - d. Test equipment manufacturer and model number

- e. Wire map
  - 1) Continuity to the remote end.
  - 2) Shorts between any two or more conductors
  - 3) Reversed pairs
  - 4) Split pairs
  - 5) Transposed pairs
  - 6) Any other miswiring
- f. Length
- g. Near-end crosstalk (NEXT)
- h. Attenuation to crosstalk ration far-end (ACRF)
- i. Power sum Attenuation to crosstalk ration far-end (PSACRF)
- j. Power sum-near-end crosstalk (PS-NEXT)
- k. Return loss (RL)
- l. Propagation delay (PD)
- m. Delay skew (DS)

- 4. Horizontal cabling shall be tested using a Permanent Link configuration as defined in TIA-568-C.
- 5. Test reports with an asterisk (\*) or fails, shall be documented identifying the reason for the test failure and a corrective action plan developed.
- 6. After corrective action has been completed, the permanent link shall be retested.
- 7. It is the Telecommunications Contractor's responsibility to ensure 100 percent of the network horizontal cabling system links pass all tests.
- 8. Test results shall be organized by building identification and cable identification number. The test results shall contain the date and time of when each test was saved in the memory of the tester. The test results shall be recorded on a flash drive in both PDF and LinkWare software formats.

D. Optical Fiber:

- 1. Acceptance Testing
  - a. Optical fiber test jumper shall be properly cleaned at both ends prior to the start of testing for each backbone segment.
  - b. A reference power measurement shall be obtained by connecting one end of test jumper 1 to the light source and the other end to the power meter tester. After recording the reference power measurement, test jumper 1 shall be disconnected from the power meter tester without disturbing the light source and attached to the cable plant. The power meter tester shall be moved to the far end of the cable plant and attached to the cable plant with test jumper 2.
  - c. Multimode optical fiber attenuation shall be tested and recorded at a minimum of three times on all individual fiber strands of each cable using the power meter tester configuration to determine the actual loss and the connector repeatability. Each of the three tests shall be recorded and a final value with the average of the three tests shall also be recorded. The connector repeatability shall not exceed 0.2 dB as defined by Telcordia GR-326-CORE. These tests shall be performed at the 850nm and 1300nm windows in bi-directional testing. Test set up and performance shall be in accordance with TIA/EIA-526-14A, Method B, and TIA-568C.0.



- d. Singlemode optical fiber attenuation shall be tested and recorded at a minimum of three times on all individual fiber strands of each cable using the power meter tester configuration to determine the actual loss and the connector repeatability. Each of the three tests shall be recorded and a final value with the average of the three tests shall also be recorded. The connector repeatability shall not exceed 0.2 dB as defined by Telcordia GR-326-CORE. These tests shall be performed at the 1310 nm and 1550 nm windows in bi-directional testing. Test set up and performance shall be in accordance with TIA/EIA-526-7, Method A.1.
- e. After terminating optical fiber cabling, one of the individual fibers of each cable segment shall be tested using an OTDR to determine the actual length. One strand of each optical fiber buffer tube shall be tested with an OTDR.

### 3.18 PATCH CORD INSTALLATION SUPPORT

- A. Provide installation of the copper and optical fiber patch cords between the active network electronics, horizontal station patch panels and voice cross-connect patch panels.
  - 1. Coordinate with the owner for patching and switch requirements.
  - 2. Contractor shall request the port identification patching matrix from the Owner in writing a minimum of three weeks in advance of starting the patch cord installation.
- B. Patch cords shall be routed in a neat and orderly fashion, maintaining proper bend radius of the patch cords as to not decrease the system performance. Utilize horizontal and vertical cable management, including all bend radius support attachments to their fullest extent.
- C. Horizontal cable management panels that contain small retainer clips at the top and bottom of the panels, a maximum of three patch cords shall be held within the retainer clips when interconnecting into patch panels or network switch ports.
- D. Patch cords with sufficient length shall be utilized as to not damage or stretch the cable jacket but the lengths shall not be more than 18 inches in excess length stored within the vertical cable management.
- E. Patch cords shall be routed horizontally in the cable management panels and transition upward and downward within the vertical cable management sections. Patch cords shall not be dressed top to bottom on the fronts of the equipment racks.
- F. At the completion of the patch cord installation, provide an updated port identification patching matrix, in Microsoft Excel format, indicating the network switch number, switch blade number and switch port number that the patch cords interconnect occurred from the horizontal station patch panel. Provide a column indicating specific function uses of the switch port such as Voice-Over-IP, wireless, streaming video and IP intercom/clock. Coordinate the specific function identifications and classifications with the Owner and Owner's Representative prior to the start of the installation. In addition, for voice cross-connects, indicate the voice cross-connect patch panel number and port that the patch cord cross-connect occurred from the horizontal station patch panel. For voice cross-connects, indicate if the port is for analog or digital use.

\*\*\*END OF SECTION\*\*\*



**SECTION 27 41 33  
TV DISTRIBUTION SYSTEM**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Provide a television distribution system and other relevant components and accessories required to provide a complete operating system as specified herein.
- B. General Requirements: Drawings and general provisions of the Contract, including General Supplementary Conditions, Division 01 sections and Section 260500 apply to the Work in this Section.

**1.02 RELATED SECTIONS**

- A. Related Sections
  - 1. 260500 – General Electrical Provisions
  - 2. 260510 – Basic Electrical Materials and Methods
  - 3. 260527 – Telecommunications Grounding System
  - 4. 260533 – Raceway Systems
  - 5. 260534 – Outlet Boxes

**1.03 QUALITY ASSURANCE**

- A. The system and its components shall be Underwriters Laboratories, Inc., listed under the appropriate UL testing standard as listed herein for TV distribution applications.
- B. Codes and Standards:
  - 1. TIA-568-C.4, Broadband Coaxial Cabling and Components Standard
- C. Qualifications:
  - 1. All TV distribution system equipment shall be installed by an authorized factory distributor. The contractor shall have furnished and installed similar systems continuously for no less than five years.
  - 2. The contractor shall hold the necessary licenses as issued by the State of Washington for a low voltage electrical contractor. Installation shall be made by a licensed and bonded contractor holding a valid Washington State Electrical Contractor's License as described in Chapter 19.28 of the Electrician and Electrical Installation Revised Code of Washington State.

**1.04 SUBMITTALS**

- A. Provide submittals in accordance with Division 01 and Section 260500.

- B. Product Data:
1. Submit with data arranged under basic categories, such as, certifications, personnel training, manufacturer warranty, products, test equipment and calibration, and similar items. Include index with the submittals.
  2. Organize by specification infrastructure component sections described in Part 1 and Part 2 of this section.
  3. Submit Product Data information sheets for coordination with item and model number.
  4. Where more than one product is shown on a page, mark product with arrow or by other means to identify exact product or products being submitted by specific part number.
- C. Test Equipment
1. Submit test equipment to be used to perform all required tests and measurements.
- D. Shop Drawings:
1. Drawings shall provide details of proposed system and the equipment and work to be provided. Drawings shall include point-to-point drawings of systems and wiring diagrams of individual devices.
  2. Connections to other equipment/systems not specified herein.
- E. Record Drawings:
1. Keep complete set of TV distribution drawings in job-site office to show actual installation of cabling and equipment during construction.
  2. Use of this set of drawings for recording as-built conditions.
  3. Indicate where material, equipment, and system component are installed differently from that shown on the Drawings.
  4. Prepare electronic set of Record Drawings, incorporating changes during construction. Submit Record Drawings to the Owner's Representative for review and acceptance.
  5. Submit Record Drawings using latest version of AutoCAD software or as approved by the Owner, and in PDF format. Request final architectural background drawing files that incorporate floor plan and program spaces numbering modifications.
    - a. AutoCAD drawings shall be e-transmitted to include backgrounds, title blocks and other associated files.
  6. Submit electronic copy of Record Drawings in full-size PDF and AutoCAD format, on flash drive.
- F. Project Closeout:
1. Submit closeout documentation to the Owner's Representative and Architect under provisions of Division 01, Section 260500 and this section.
  2. Provide all project closeout documentation including but not limited to; test acceptance documentation, Record Drawings, manufacturer warranty and Operation and Maintenance Manuals.

3. Test Reports:
  - a. Field test reports
  - b. Submit completed copy of reports and include copy in the Operation and Maintenance Manual

1.05 **OWNER FURNISHED CONTRACTOR INSTALLED (OFCI) EQUIPMENT**

- A. Material Handling and Delivery: Coordinate delivery of OFCI equipment. Receive, off load, transport, store, hoist, unpack, dispose of packing, same as for other project equipment arriving at job site. Requirements of the Contract Documents apply to OFIC equipment.
- B. Operation and Maintenance Data: Obtain from the Owner operation and maintenance data for the OFCI equipment and incorporate them into the Operations and Maintenance Manuals.

1.06 **SYSTEM REQUIREMENTS**

- A. The system shall receive television signals from local cable TV provider, amplify these signals, and distribute them to TV outlets to permit simple connection of ATSC standard television receivers.
- B. The system shall deliver at outlets ATSC color television signals without introducing noticeable effect on intelligence and color fidelity. System picture quality shall be equal to that received from the cable company and other modulated channels.
- C. The system and all equipment shall be designed and rated for 24-hours-a-day continuous operation.

PART 2 - EQUIPMENT

2.01 **MANUFACTURER**

- A. Substitutions: The substitution of products shall not be considered under the terms and conditions of this Section.

**OR**

- B. Substitutions: The substitution of products shall adhere to the requirements defined in Section 260500 – Substitutions.
  1. Audio visual equipment shall be from a manufacturer with at least 5 years of experience in the manufacturing of equipment.
    - a. Approved manufacturers:
      - 1) Blonder-Tongue or approved equal

## 2.02 EQUIPMENT RACK AND ACCESSORIES

- A. Equipment rack shall support rack for amplifiers, filters, modulators, splitters, and head-end origination equipment. Rack shall be complete with 19 inch rack fixed rails, louvered ventilation slots, and hinged lockable rear door. The rack shall have dimensions 74.20"H x 23.06"W x 22"D with a racking space of 40 rack units. The rack shall be fully welded 18 gauge steel with seamless construction and 16 gauge steel bottom.
  - 1. Include blank panels for all unused spaces.
    - a. Manufacturer Lowell, Part No. LBR-4022
- B. Provide equipment rack hardware, shelves, and blank panels as specified. Provide tamperproof screws to secure all equipment.
  - 1. Manufacturer Lowell:
    - a. 1U blank panel, Part No. SEFP-1
    - b. 2U blank panel, Part No. SEFP-1
    - c. Tamperproof screws, bag (50), Part No. RSV-50
    - d. Drive bit, Part No. RSV-BIT
    - e. Equipment shelf, Part No. US-414

## 2.03 MAIN AMPLIFIER

- A. Main amplifier shall be provided for all available DTV channels. Each unit shall be of solid-state design, contain its own power supply, and have a manual gain control. The amplifier shall have a passive return path.
  - 1. The amplifier shall meet the following specifications:
    - a. Gain: 30 dB minimum, 15 dB gain control range
    - b. Frequency range: 47 to 750 MHz
    - c. 75-ohm input and output
  - 2. Manufacturer Blonder Tongue, Part No. ACA 30-75R

## 2.04 DISTRIBUTION AMPLIFIER

- A. Distribution amplifiers shall be provided as required. Amplifier shall be capable of 2-way operation.
  - 1. Amplifiers shall be of solid-state design with the following specifications:
    - a. Gain: 31 dB minimum, 15 dB gain control range
    - b. Frequency range: 47 to 860 MHz
    - c. 75-ohm input and output
  - 2. Manufacturer Blonder Tongue, Part No. ACA 30-86R

**2.05 CHANNEL ELIMINATION FILTER**

- A. Include channel elimination filters for channels selected by the Owner. Filter shall have a minimum rejection of at least 55 dB of the specified channel.
  - 1. Manufacturer Blonder Tongue, Part No. CEF-750

**2.06 LINE SPLITTERS**

- A. Line splitters shall be indoor solder back digital splitters with a frequency response 5 to 1000 MHz. The two-way line splitter shall have a signal loss of not more than 3.7 dB. The four-way splitter shall have a signal loss of not more than 7.5 dB.
  - 1. Unused outputs on the splitter and end of runs shall be terminated with 75-ohm terminators.
    - a. Manufacturer Blonder Tongue:
      - 1) Two-way splitter, Part No. PBT
      - 2) Terminator, Part No. DGS series

**2.07 DIRECTIONAL TAPS**

- A. Directional taps shall be indoor solder back low intermodulation digital taps with a frequency response 5 to 1000 MHz
  - 1. Taps shall be available in 1, 2, 4 and 8-port models with machine threaded F-connector ports.
  - 2. Taps values shall range from 6dB to 30dB
    - a. Manufacturer Blonder Tongue, Part No. SRT series.

**2.08 OUTLETS**

- A. Outlets shall be provided at each location shown on the plans, and mounted in 2-inch deep minimum flush electrical boxes as indicated on the plans. Outlets shall be designed to cover a frequency range of 10 MHz to 750 MHz. Insertion loss shall not exceed 1.0 dB at any frequency within the designated frequency range for 17 dB isolation network. Outlets shall have one F-type connector on the front, and two F-type trunk connectors.
  - 1. Manufacturer Blonder Tongue, Part No. V-3889

**2.09 CABLE**

- A. Cabling shall be a low radiation broadband coaxial CATV cable with a nominal characteristic impedance of 75 Ohms throughout the entire frequency spectrum utilized in this system.
- B. RG 6/U coaxial cable for drop cabling shall be UL listed CMR for use in riser application. Cables shall have 18 AWG bare copper covered steel conductor and FEP foam core dielectric with nominal impedance of 75 Ohms. Cable shall have aluminum polyester foil shield with 60% aluminum braid.
  - 1. Manufacturer Belden, Part No. 9116R

- C. RG 6/U coaxial cable for drop cabling shall be UL listed CMP for use in plenum rated. Cables shall have 18 AWG bare copper covered steel conductor and foam FEP insulation with nominal impedance of 75 Ohms. Cable shall be quad shielded. The first shield shall be Aluminum Foil-Polyester Tape-Aluminum Foil tape bonded to dielectric with the second shield a 60% aluminum braid. The third shield shall be an Aluminum Foil-Polyester Tape-Aluminum Foil tape and the fourth shield a 40% aluminum braid.
  - 1. Manufacturer Belden, Part No. 1189AP
- D. RG 11/U coaxial cable for intrabuilding backbone applications shall be UL listed CMR for use in riser application. Cables have 14 AWG bare copper-covered steel conductor and gas-injected foam polyethylene core with nominal impedance of 75 ohms. Cable shall have aluminum polyester foil shield with 60% aluminum braid.
  - 1. Manufacturer Belden, Part No. 1523R
- E. RG 11/U coaxial cable for interbuilding backbone applications shall be listed for use in wet environments. Cables shall have 14 AWG solid copper conductor and gas-injected foam polyethylene core with nominal impedance of 75 Ohms. Cable shall have aluminum polyester foil shield with a 60% aluminum braid.
  - 1. Manufacturer Belden, Part No. 1525A

#### 2.10 OPEN CABLING & DEVICE MOUNTING SUPPORTS

- A. Provide all accessories and mounting hardware required for a complete and working installation of open cabling supports.
- B. Hook & Loop Fasteners:
  - 1. Hook and loop fastener rolls shall be 0.5-inch in width. Shear strength for plenum hook and loop fasteners shall be 29 PSI. Hook and loop fasteners installed in plenum air spaces shall be UL Listed (plenum) and be in the color maroon.
    - a. Manufacturer Leviton, plenum, Part No. 43115-75P or equal
  - 2. Hook and loop fastener rolls shall be 0.5-inch in width. Shear strength for non-plenum hook and loop fasteners shall be 23 PSI.
    - a. Manufacturer Leviton, non-plenum, Part No. 43115-75 or equal
- C. J-Hooks
  - 1. J-hooks shall comply with TIA requirements for structured cabling systems and pathway supports. Galvanized finish. Provide all hardware and hanger rod supports necessary for secure mounting to the structure. Follow manufacturer's recommendations for quantity of cables supported.
    - a. Manufacturer Erico Caddy, Part No. CAT12HP



PART 3 - INSTALLATION

3.01 **INSTALLATION**

- A. Provide all labor, tools, supplies, software, hardware, materials, and equipment required for the design, installation, configuration/programming and testing of a complete and operational system.
- B. System shall be installed in accordance with details on the Contract Documents and manufacturer's installation instructions.
- C. Cabling shall be installed in conduit, cable tray or using open cabling methods when installed above accessible ceilings.
- D. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.
- E. Cabling shall not be enclosed in conduit or raceways containing AC power.
- F. All devices shall be securely mounted. Provide necessary backing in walls or ceilings.
- G. Properly ground the system per NEC requirements to the building safety grounding system to prevent electrostatic charges and other transient electrical surges from damaging the control panel.
- H. Install coaxial cables in continuous lengths except for terminations. Splices not allowed. Install cable to avoid sharp bends and physical distortions.

3.02 **OPEN CABLING SUPPORT INSTALLATION**

- A. All cable that is installed above suspended ceiling areas shall be run in j-hooks above the ceiling grid and will not be allowed to lay on the grid.
  - 1. Provide all hanger supports and cable supports for cabling specified in this section, unless routed within conduit. All support structures shall adhere to the requirements in the National Electrical Code.
  - 2. Cabling supports shall be spaced no further than 4-feet-0-inches apart.
  - 3. Cabling bundles shall not sag, a maximum of two-inches from the bottom of the cable support.
  - 4. Cabling supports shall be installed on their own support system. The use of ceiling grid supports shall be prohibited.
- B. Twisted pair cabling utilizing open cabling methods shall maintain a minimum separation of three inches from fire alarm, intercom paging, security and CATV broadband cabling. Cabling supports shall maintain increased separation requirements when attaching to the same hanger rod to ensure cabling sag maintains the minimum three inch separation.
- C. Microphone cabling shall be run in a separate conduit and/or open cabling supports. Speaker cabling shall be run in a separate conduit and/or open cabling supports.
- D. Maintain the following distances between cabling and other building systems:
  - 1. One foot from fluorescent lights.
  - 2. Six feet from motors and transformers.

3. Three feet from water piping or other mechanical equipment.
  4. One foot from electrical conduits or other electrical equipment.
- E. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit or other system supports. Cabling shall never come in physical contact with these mechanical, fire protection and electrical systems and raceways.

### 3.03 LABELING

- A. Provide machine generated wrap around label on both ends of the cabling jacket no more than 4-inches from each termination point.
- B. Tag cables terminating at amplifiers and splitters as to function and destination.

### 3.04 SYSTEM TESTING

- A. On completion of the installation of the system, the subcontractor supplying equipment shall make available a qualified technician to perform the following tests:
  1. The overall system shall be broadband tested with a field strength meter from the head-end location to the last outlet in each distribution leg of the system.
  2. The system shall deliver a minimum signal level of +6 dBmV/2000 mv across 75 Ohms on each channel at each outlet.
  3. Certify that no frequency drop-outs are present in the distribution system which would affect any of the VHF channels.
  4. Using a return loss bridge, certify that return loss of system shall be a minimum of 26 dB down. VSWR shall not exceed 1.4:1.

### 3.05 FINAL ACCEPTANCE

- A. Contractor shall submit a request for the Acceptance test in writing to the Owner no less than twenty-one days prior to the requested test date. The request for acceptance test shall constitute a certification from the Contractor that all Work is complete and in compliance with the Contract Documents; all systems have been tested; and that all corrections have been made.
- B. Acceptance test shall be scheduled during a period when the building is unoccupied, and a complete system test can be accomplished. Contractor shall provide the services of no fewer than two (2) technicians to perform the acceptance test. Technicians performing the acceptance test shall have been involved in the installation of this project and shall be thoroughly familiar with all aspects of the Work. Technicians shall be equipped with portable two-way radios that will be used during the test.
- C. Contractor shall provide all ladders, tools, test equipment, and other facilities needed to accomplish the Acceptance test.
- D. During acceptance test, Contractor shall demonstrate all equipment and system features to the Owner. Contractor shall fully cooperate with the Owner and provide assistance with the inspection and test. Contractor shall remove and reinstall covers, open and restore wiring connections, operate equipment, and perform other reasonable work as requested by the Owner.

- E. Any portions of the Work found to be deficient or not in compliance with the Contract Documents will be rejected. Owner will record any such deficiencies observed during the Acceptance test. A copy of said list will be provided to Contractor. Contractor shall promptly correct all deficiencies.

**3.06 WARRANTY AND SERVICE**

- A. Contractor shall provide parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of one (1) year from Date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.
- B. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment. Correct any system defect within twenty-four (24) hours of receipt of call from the Owner.

**3.07 TRAINING**

- A. The Owner shall receive 4 hours of instruction in (2) 2-hour segments covering all aspects of operating the TV distribution system.

\*\*\*END OF SECTION\*\*\*

**SECTION 28 00 00  
ELECTRICAL SAFETY AND SECURITY WORK SPECIFIED IN DIVISION 26**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

A. Description: The following sections apply to Work in this Division:

- |     |                |  |
|-----|----------------|--|
| 1.  | Section 260500 | General Electrical Provisions                                  |
| 2.  | Section 260510 | Basic Electrical Materials and Methods                         |
| 3.  | Section 260511 | Electrical Connections for Equipment                           |
| 4.  | Section 260519 | Wire and Cables  |
| 5.  | Section 260527 | Telecommunications Grounding System                            |
| 6.  | Section 260529 | Supporting Devices   |
| 7.  | Section 260533 | Raceway Systems  |
| 8.  | Section 260534 | Outlet Boxes   |
| 9.  | Section 260535 | Floor Outlet Devices   |
| 10. | Section 260536 | Cable Trays  |
| 11. | Section 260543 | Underground Vaults and Raceways                                |
| 12. | Section 260548 | Vibration Isolation and Seismic Control for Electrical Systems |
| 13. | Section 260553 | Electrical Identification                                      |

**PART 2 - PRODUCTS**

Not used.

**PART 3 - EXECUTION**

Not used.

\*\*\*END OF SECTION\*\*\*



**SECTION 28 13 00  
ACCESS CONTROL SYSTEM**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Description: Provide an expansion of the City's existing electronic access control system and other relevant components and accessories required to provide a complete operating system as specified herein.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 sections and Section 260500 apply to Work in this section.

**1.02 RELATED SECTIONS**

- A. Related Sections
  - 1. 260500 – General Electrical Provisions
  - 2. 260510 – Basic Electrical Materials and Methods
  - 3. 260533 – Raceway Systems
  - 4. 260534 – Outlet Boxes
  - 5. 271100 – Telecommunications System

**1.03 QUALITY ASSURANCE**

- A. The system and its components shall be Underwriters Laboratories, Inc., listed under the appropriate UL testing standard as listed herein for security access control applications.
- B. Codes and Standards:
  - 1. American National Standards Institute (ANSI):
    - a. ANSI C63.4 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
  - 2. Federal Communications Commission (FCC):
    - a. Title 47 CFR – Part 15; Class B – Radiated and Conducted Emissions.
    - b. Title 47 CFR – Part 68; rules governing the connection of Terminal Equipment (TE) to the Public Switched Telephone Network (PSTN).
  - 3. Underwriters Laboratories, Inc. (UL):
    - a. UL 50 – Enclosures for Electrical Equipment.
    - b. UL 294 – Access Control System Units.
    - c. UL 60950-1 – Information Technology Equipment - Safety.

4. National Fire Protection Agency (NFPA):
    - a. NFPA 101 Life Safety Code.
  5. Provide all wiring in accordance with Article 725 of the National Electrical Code and local ordinances, and other sections of these specifications.
- C. Qualifications:
1. Contractor shall be a certified reseller/dealer, pre-qualified by the manufacturer for the purpose of offering the services as specified herein, at the time of bid.
  2. Contractor's bidding security work shall have a minimum of five years of experience in the construction, testing, and servicing of systems of the type and magnitude specified herein.
  3. The contractor shall have completed at least five projects of equal or larger in size to this project within the past five years.
  4. Contractor shall have direct access to the tools and test equipment required to complete the work as defined herein.
  5. The contractor shall employ certified technicians skilled in the maintenance of the access control system and shall be located within 100 miles of the project site.

#### 1.04 SUBMITTALS

- A. Provide submittals in accordance with Division 01 and Section 260500.
- B. Product Data:
1. Submit with data arranged under basic categories, such as, certifications, personnel training, manufacturer warranty, products, test equipment and calibration, and similar items. Include index with the submittals.
  2. Organize by specification infrastructure component sections described in Part 1 and Part 2 of this section.
  3. Submit Product Data information sheets for coordination with item and model number.
  4. Where more than one product is shown on a page, mark product with arrow or by other means to identify exact product or products being submitted by specific part number.
  5. Submit resumes and certifications of technicians and project manager who will support this project. Certifications shall include:
    - a. Manufacturer's certification to provide warranty.
    - b. Approved manufacturer classes satisfactorily completed.
- C. Acceptance Test Plan:
1. An acceptance test plan form shall be prepared/provided by the contractor.
  2. This form shall include separate sections for each device and a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.

D. Shop Drawings:

1. Drawings shall provide details of proposed system and the equipment and work to be provided. Drawings shall include devices located on the floor plan, point-to-point drawings of systems and wiring diagrams of individual devices including voltage drop calculations and other calculations as required.
2. Connections to other equipment/systems not specified herein.

E. Record Drawings:

1. Keep complete set of security drawings in job-site office to show actual installation of cabling and equipment during construction.
2. Use of this set of drawings for recording as-built conditions.
3. Indicate where material, equipment, and system component are installed differently from that shown on the Drawings.
4. Prepare electronic set of Record Drawings, incorporating changes during construction. Submit Record Drawings to the Owner's Representative for review and acceptance.
5. Submit Record Drawings using latest version of AutoCAD software or as approved by the Owner, and in PDF format. Request final architectural background drawing files that incorporate floor plan and program spaces numbering modifications.
  - a. AutoCAD drawings shall be e-transmitted to include backgrounds, title blocks and other associated files.
6. Submit electronic copy of Record Drawings in full-size PDF and AutoCAD format electronically or on flash drive.

F. Project Closeout:

1. Submit closeout documentation to the Owner's Representative and Architect under provisions of Division 01, Section 260500 and this section.
2. Provide all project closeout documentation including but not limited to; test acceptance documentation, Record Drawings, manufacturer warranty and Operation and Maintenance Manuals.

1.05 **SYSTEM REQUIREMENTS**

A. Type of System:

1. The system shall be programmable locally and/or remotely.
2. Access control system shall provide the following card access control operational objectives:
  - a. Controlled entry, via access card readers, of only authorized personnel to secured areas based on cardholder information entered and stored in the system database.
  - b. Access request response time from card presentation, data base verification, to electric lock unlock shall be no more than one second in normal operating mode on a fully loaded system.
  - c. Access requests, both authorized and denied, shall be sent to the host for storage and annunciation, as required, with the cardholder number, name, and access point/area where access was attempted or gained.



- d. Each card can be disabled at any time, manually or scheduled within the system.
  - e. Each cardholder shall be granted with access authority to a specific or combination of security areas.
  - f. System shall provide for the designation of certain calendar days to be holidays, with special access privileges and system activity to be specified for those days.
3. The system shall provide the following relay output control and operational functions:
- a. Each point shall be software programmable for activation and deactivation, and shall be capable of reporting short circuit trouble, open circuit trouble, ground fault trouble and circuit fault trouble.
  - b. System shall allow activation and deactivation of output points manually by the operator, automatically by time zone, automatically by the activation of an alarm point, or where required by a card reader.
  - c. System shall allow disabling the exterior auto operator button when door hardware is in a locked state.
4. System shall provide lockdown functions via push buttons as indicated on the Contract Documents.
- a. When the lockdown button is activated, it shall override all scheduled openings and lock/close all electronic controlled doors/gates.

**1.06 PRE-CONSTRUCTION MEETINGS**

- A. The subcontractor shall attend the pre-construction meeting as required by the Contractor or the Owner's Representative.
- B. Provide a schedule, indicating installation tasks, time duration for each task and coordination items to be discussed 5 days prior to the meeting, to the Contractor and to the Owner's Representative.

**1.07 MATERIAL PROVISIONS**

- A. Deliver materials to the Owner under provisions of this section.
- B. Contractor shall be responsible to provide a material transmittal for all materials being provided to the Owner as described herein and that are not permanently installed. Transmittal shall be signed by the General Contractor and the Owner receiving the materials.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Substitutions: The substitution of products shall not be considered under the terms and conditions of this Section.
1. Access control panels and equipment shall be from a manufacturer with at least 5 years of experience in the manufacturing of equipment.
    - a. Approved manufacturers:
      - 1) Controllers/modules: Mercury
      - 2) Readers & Credentials: HID
- B. Access Control System Software
1. The existing Access Control System is Open Options dnaFusion. Access control software resides at City Hall. Access Control expansion to be connected via city fiber optic network between City Hall and Operations Building A.
- C. Access Control System:
1. Security Management System (SMS) Hardware: SMS shall be equipped with the access control field hardware required to receive alarms and administer all access granted or denied decisions. All field hardware must be designed to meet UL 294 requirements. SMS must be able to retrieve device serial numbers from all field hardware, excluding card readers, biometric readers, and keypads. Contractor shall be responsible for determining the final quantity of devices based on the Contract Documents.
- D. Intelligent System Controller:
1. Controller shall support up to 64 portals/32 interface modules, two onboard portals with eight inputs and four outputs, communicate with serial I/O devices via RS-485 and communications over IP to host.
    - a. Manufacturer Mercury, Part No. LP-1502/MP-1502 (latest version available)
- E. System Hardware:
1. Access control panel shall be an UL 294-Listed enclosure. Controllers, modules, and misc. equipment shall be provided as required to support all end devices specified herein and as shown on the Contract Drawings. Single reader modules are not acceptable.
    - a. Manufacturer Mercury (latest version available):
      - 1) Dual reader module, Part No. MR52-S3B
      - 2) Input Control Module, Part No. MR16IN-S3
      - 3) Output Control Module, Part No. MR16OUT-S3

## 2.02 POWER SUPPLIES AND BATTERIES

### A. Enclosure and Power Supplies:

1. Access control panel enclosure shall include dual 12V/24V power supply, 8-door shall be 150 watts, 16 door shall be 400 watts. It shall have 8 or 16 managed outputs fused at 3.0 amps, and 8 or 16 aux. outputs at 2.5 amps each with tamper switch to match the number of doors.
  - a. Manufacturer Altronix Trove:
    - 1) 8-door enclosure, Part No. T2M7XK1D
    - 2) 16-door enclosure, Part No. T3M77XK1D

### B. Batteries:

1. Batteries and associated equipment shall be provided as required to support the system as specified herein with a minimum 4-hour battery backup.
  - a. Manufacturer Power Sonic, 12V 7Ah, Part No. PS-1270

## 2.03 ACCESS CONTROL DEVICES

### A. Readers:

1. Signo Readers
  - a. Contactless smart card reader shall comply with the ISO 13.56MHz-related standards and bidirectional communication in compliance with v2 of the SIA OSDP (Open Supervised Device Protocol) standard. Shall support 125 kHz proximity FSK (HID Proximity, AWID). PSK (Indala) and ASK (EM4102) 125 kHz technology.
  - b. Contactless smart card reader shall follow the standards-based, device-independent Security Identity Object™ (SIO) portable credential methodology. The SIO shall be able to reside on any number of identity devices, including Seos, iCLASS SE, iCLASS SR, MIFARE Classic, and MIFARE DESFire EV1/EV2 credentials.
  - c. Contactless smart card reader shall support, by default, Apple's Enhanced Contactless Polling (ECP) to support credentials in the Apple Wallet and Bluetooth Low Energy (BLE) and NFC card emulation mode. Reader shall be environmental rating of IP65.
    - 1) Manufacturer HID:
      - a) Mullion reader, Part No. 20NKS-00-000000
      - b) Mullion PIN pad reader, Part No. 20KNKS-00-000000
      - c) Standard reader, Part No. 40NKS-00-000000
      - d) Standard PIN pad reader, Part No. 40KNKS-00-000000
2. Long Range iCLASS SE Reader
  - a. Long range readers shall be designed to securely read, interpret, and authenticate access control data from 13.56 MHz contactless smart card credentials.

- b. Long range reader shall have read range distance of 3 – 5 meters.
- c. Reader shall support HID SIO Enabled Single Technology UHF, SIO Enable Dual Technology UHF/iCLASS, UHF EPC, Class 1, Gen 2 ISO 18000-6C credentials. Reader shall have dimensions of 9.10"H x 9.10"W x 2.75"D.
  - 1) Manufacturer HID, Base Part No. RDRSEU90

## 2.04 CONTROL BUTTONS AND RELAYS

- A. Emergency Lockdown Button (Under Desk Mount):
  - 1. Emergency lockdown button shall be maintained, normally open DPDT contact.
    - a. Manufacturers, or approved equal:
      - 1) Honeywell, Part No. 269R
      - 2) Potter, Part No. HUB-M
      - 3) Rofu, Part No. 1010
- B. Emergency Lockdown Button (Wall Mount):
  - 1. Emergency lockdown button shall be red twist release mushroom style, blue shell white lettering reading "LOCKDOWN", maintained, normally open SPST contact with protective cover.
    - a. Manufacturer STI, Part No. SS2421LD-EN
- C. Door Release Button (Under Desk Mount):
  - 1. Door release button shall be momentary, normally open DPDT contact.
    - a. Manufacturers, or approved equal:
      - 1) Rofu, Part No. 1010
      - 2) Potter, Part No. HUB-M
- D. Door Release Button (Wall Mount):
  - 1. Door release button shall be green in color, momentary, normally open with Form "C" contacts. Custom button label shall read "PUSH TO OPEN" and faceplate label shall read "DOOR RELEASE".
    - a. Manufacturer STI, Part No. UB-1
- E. Auto Operator Time Delay Module
  - 1. Auto operator time delay module shall be designed to have programmable modes that include up to 3 door sequencing, airlock, lock-out relay, fire door in stairwells, and for control of automatic operators in restroom applications, with support of illuminated indicator of occupancy status.
    - a. Manufacturer Camden, Part No. CX-33

2.05 **MONITORING DEVICES**

- A. Request-to-exit (REX):
1. Doors with electronic door hardware shall contain an internal micro switch REX device, coordinate with Division 08.
  2. Request-to-exit device shall be UL 1638 and UL 464. REX shall feature timers, door monitor with sounder alert, and adjustable coverage, the REX shall have Sequential Logic Input (SLI). REX shall operate at 12VDC with 8mA nominal standby current and 39 mA in alarm. Alarm output shall be by two Form C relay contacts each rated 1 A at 30VAC/VDC for resistive loads.
    - a. Manufacturer Bosch, Part No. DS160
- B. Magnetic Door Position Switches:
1. Recessed
    - a. Door contacts shall be UL listed 1-inch diameter magnetic door contact DPDT (double pole/double throw) switch. Contact shall be self-locking for recessed mounting, closed loop, with 12-inch 22 AWG leads and 1-inch gap.
    - b. Hardware, mounting brackets, adapters and plates shall be provided as required for magnetic contact switch installation.
      - 1) Manufacturer Nascom, Part No. N1178Cx/STDD, or approved equal
        - a) x = denotes color, (W) white, (T) tan, (G) gray and (B) brown.
  2. Surface Mount
    - a. Door contact shall be a hermetically sealed reed switch nominally 3"L x 1"H x 0.50"D with matching actuating magnet. Mounting holes shall be on 2-inch centers. Contact and magnets shall be in brushed anodized aluminum tube housing. Contact shall be sealed in our exclusive polyurethane potting compound. Right angle mounting bracket shall be included with contact.
      - 1) Manufacturer Edwards Signaling, Part No. 2507AD-L
  3. Overhead Surface Mount
    - a. Overhead door contacts shall be UL Listed heavy-duty SPDT (Single-pole-double-throw) surface mounted magnetic contacts with 3-inch minimum gap size.
      - 1) Manufacturer Nascom, or approved equal:
        - a) Channel mount, Part No. N505AUTMC/STSD

4. Specialty Magnets

- a. Where door contacts are required at metal store front doors with top channel provide channel magnet, clip legs to accommodate shallow channel. Magnet shall be housed in flexible plastic housing with legs at each corner.
  - 1) Manufacturer George Risk Industries, Part No. MC-180, or approved equal.

2.06 **ELECTRONIC LOCKING HARDWARE**

- A. Electronic locking hardware shall be provided by Division 08.

2.07 **GATE PEDESTAL AND HOUSING**

- A. See Section 32 31 11.

2.08 **CABLING AND CONNECTIVITY**

- A. Cabling shall be sized to provide minimum resistance and minimum voltage drop to the devices being supplied. Voltages delivered to all devices shall be within the tolerance specified by the device manufacturer.
  - 1. Cabling shall be a minimum 18 AWG copper conductors for power connectivity.
  - 2. Twisted pair cable shall be used to prevent EMI/RFI interference with the proper operation of the circuits.
- B. Cable shall be UL1666, IEC332-1, CMR (riser) rated unless otherwise noted.
  - 1. Cables installed in underground applications shall be rated for wet environments.
- C. Cables shall adhere to the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
  - 1. Wiring shall be appropriately color-coded with permanent wire markers.
  - 2. Cabling shall have stranded copper conductors.
    - a. Card readers: 18 AWG-6C with overall shield
    - b. RS-485/OSDP: 24 AWG two twisted pair with overall shield
    - c. Door position switch: 22 AWG-2C
    - d. Lockdown/door release button, keyed switch: 18 AWG-4C
    - e. Request to exit (PIR): 22 AWG-4C
    - f. Request to exit (integral): 22 AWG-4C (2C spare)
    - g. Electrified lock/exit device: 18 AWG-4C
      - 1) Refer to manufacturer requirements.
    - h. ADA integration: 18 AWG-4C
    - i. Electrified mag lock/hold open: 16 AWG-2C
    - j. Sounder/strobes w/tamper switch: 18 AWG-4C

- D. Coordinate additional cabling requirements, other than those listed herein, for devices within the access control system shop drawings.
  - 1. Approved manufacturers: Windy City Wire and Beldon
- E. End-of-Line Resistors:
  - 1. End-of-line (EOL) resistor pack with 1000-Ohm supervisory resistor.
    - a. Manufacturer George Risk Industries, Part No 6644
- F. Cable Management:
  - 1. Cable management shall be provided inside of panels and shall consist of 2-inch PVC wire duct with cover in gray color.
    - a. Manufacturer Panduit, Part No. C2LG6 PVC
- G. Terminal Blocks:
  - 1. Terminal blocks shall be screw-in connection, two connections with 1 position, 24 – 12 AWG and mount on DIN rails within a minimum 12-inch x 12-inch x 6-inch NEMA 1 junction-box.
    - a. Manufacturer Schneider Electric, Altech or equal
- H. PoE Lock Termination Enclosure:
  - 1. Enclosure shall mount on a standard 12-inch-wide x 12-inch-high x 6-inch deep NEMA 1 box. Enclosure shall have a 14-inch square frame with locking door with a 2.5-inch recessed 10.5-inch square mounting panel. Enclosure cover shall be flush with reversible door hinges.
    - a. Manufacturer Whirlwind, Part No. WFFD12X2.5KIT or approved equal
- I. Splices:
  - 1. Cable to cable splices shall be terminated using solder/heat-shrink assemblies.
    - a. Manufacturer TE Connectivity, Part No. CPGI-CWT series or equal

## 2.09 LABELING

- A. Cable labels shall be heat-shrinkable, white with black thermal transfer lettering.
  - 1. Manufacturer Hellermann Tyton, ShrinkTrak series or equal

**2.10 MATERIAL PROVISIONS**

A. Materials shall be provided to the Owner as specified herein.

Item	Manufacturer	Description	Part No.	Provide
1	Mercury	2-Door Controller	MR52-S3B	2
2	Mercury	Intelligent System Controller	MP-1502	1
3	HID	Card Reader	2ONKS-00-000000	2

**PART 3 - EXECUTION**

**3.01 IP DEVICE MATRIX**

A. Provide an IP Address matrix, in Microsoft Excel format, indicating the devices; make, model, MAC address, cable port number, room name and room number. Coordinate the specific function identifications and classifications with the Owner and Owner's Representative prior to the start of the installation. Submit to Owner's Representative to receive IP Addresses prior to installation of system.

**3.02 INSTALLATION**

- A. Provide all labor, tools, supplies, software, hardware, materials, and equipment required for the design, installation, configuration/programming, and testing of a complete and operational system.
- B. Install all equipment in accordance with manufacturer's instructions, approved Shop Drawings and as indicated on the Contract Documents.
- C. Cabling shall be installed in conduit at non accessible locations, cable tray or open cabling supports in accessible ceiling spaces.
- D. Where subject to mechanical damage, cabling shall be enclosed in metallic conduit and/or surface metallic raceway.
- E. Cabling shall not be enclosed in conduit or raceways containing AC power.
- F. All devices shall be securely mounted. Provide necessary backing in walls.
- G. Splices shall be terminated with or solder/heat-shrink connectors, twist/wire nuts and crimp connectors are not acceptable.
- H. Enclosures shall have lock & key and tamper switch; tamper switch shall be connected to an input module.
- I. Properly ground the system per NEC requirements to the building safety grounding system to prevent electrostatic charges and other transient electrical surges from damaging the control panel.
- J. Access control panels shall be located as indicated on the Contract Documents.



- K. Door hardware power supplies (by Division 08, if required) shall be located in the telecommunications rooms.
- L. Provide connection(s) to door release button(s), where indicated on the Contract Documents.
  - 1. Button(s) mounted under worksurfaces shall be located to the left or right side of the knee space and no more than 1-inch from front edge of the worksurface.
- M. Relays shall be installed at the access control panel or on the secure side of the door. Where located remotely relays shall be installed inside of a minimum 12-inch x 12-inch x 6-inch NEMA 1 junction-box located above accessible ceiling spaces.
- N. Auto operator motor (ADA button): provide relays and cabling for card reader operation with ADA operators. Coordinate requirements with the electrical and door hardware contractors.

### 3.03 LABELING

- A. General:
  - 1. Labels shall be permanent typewritten labels produced by a labeling machine.
  - 2. Labels shall be installed on cabling at each end with wrap around labels. Ensure labels are securely fastened.
  - 3. Labels shall be located within 6 inches of cable termination and placed so they can be easily read.
  - 4. Font type shall be Arial.
  - 5. Labeling shall be completed prior to the substantial completion date of the project.
- B. Device Labeling:
  - 1. Devices shall be named within the system as follows:
    - a. S.D.100.X where:
      - 1) S = Site ID
      - 2) .D = Device ID (D = door position switch, CR = card reader, Ri = REX integral, Re = REX external, L = lock power, H = horn/strobe, LD = lockdown, DR = door release, PB = panic/duress button, RS = RS-485 (bus/backbone), B = battery, E = equipment connection, etc.)
      - 3) .100 = Area ID (where applicable)
      - 4) .X = Room number & location (i.e., N, NW, S, SE, etc.)
- C. Cable Labeling:
  - 1. Labeling shall be heat-shrinkable, white with black thermal transfer lettering. The labeling shall be as follows:
    - a. 100.X.Y where:
      - 1) 100 = Door/room number
      - 2) .X = Device ID (D = door position switch, CR = card reader, Ri = REX integral, Re = REX external, L = lock power, H = horn/strobe, LD = lockdown, DR = door release, PB = panic/duress button, RS = RS-485 (bus/backbone), B = battery, etc.)

- 3) Y = where multiple of the same devices are in the same room (i.e., N, NW, S, SE, etc.)

D. Panel Labeling:

1. Panel ID labeling shall be placed on the front cover of the enclosure. The labeling shall be as follows:
  - a. 120.ACP.1 where:
    - 1) 120 = Room ID (as indicated on the Contract Drawings)
    - 2) .ACP.1 = Panel name and number
  2. For panels located above the ceiling a label shall be provided on the ceiling grid. The label shall be machine generated. The text shall be in bold white letters on black background printed on 3/4-inch tape with the maximum font size allowable. The labeling shall be as follows:
    - a. 1001A.ACP where:
      - 1) 1001A = Door ID (as indicated on the Contract Drawings)
      - 2) .ACP = Panel name
        - a) ACP = access control panel, RLY = relay enclosure, PS = power supply
    - b. Label panel cover with duplicate label with 2-inch white letters.
  3. Circuit ID label shall be on the front of the enclosures. Labeling shall contain the electrical panel and circuit number connected to the panel and power supply.

E. Battery Labeling:

1. Labeling shall be placed on the side of the battery viewable when opening the front cover of the panel. The labeling shall be as follows:
  - a. 120.B.1-XX/YYYY where:
    - 1) 120 = Room ID (as indicated on the Contract Drawings)
    - 2) .B.1 = Battery ID no. (per room)
    - 3) -XX/YYYY = Month/Year of installation

3.04 OPEN CABLING SUPPORT INSTALLATION

- A. All cabling shall be run exposed as "open cabling" in ceiling spaces and ceiling plenums, unless otherwise noted.
- B. Provide all hanger supports and cable supports for cabling specified in this section. All support structures shall adhere to the requirements in the National Electrical Code.
- C. Cabling supports shall be spaced no further than 4'-0" apart.
- D. Provide all additional cable management products as required to protect exposed cabling and complete the installation of cabling in a neat professional manner.

- E. Cabling supports shall be installed on their own support system. The use of ceiling grid supports shall be prohibited.
- F. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit or other system supports. Cabling shall never come in physical contact with these mechanical, fire protection and electrical systems and raceways.
- G. Cabling bundles and supports changing pathway direction shall maintain proper bend radius as to not impact the physical jacket construction of the cabling. Cabling that becomes damaged during this transition shall be replaced in its entirety.
- H. Follow manufacturer's recommendations for quantity of cables supported in J-hooks and adjustable cable supports.

### 3.05 PROGRAMMING

- A. Programming of the system shall include, but not limited to:
  - 1. Programming system configuration parameters (hardware and software, area/circuit numbers, communication parameters).
    - a. See Device Labeling herein for device naming in the system.
  - 2. Programming user/groups, door groups, creating maps, door schedules, access cards and/or e-mail notifications as defined by the Owner.
  - 3. When the door is locked the LED on the card reader shall be red, when the door is unlocked momentarily via software/valid read or scheduled unlock the LED on the card reader shall be green for the duration of the unlock state. When the door returns to a locked state the LED shall be red.
  - 4. If a credential is presented to a reader during a time or date that is not within its programmed privileges, the door shall not unlock.
  - 5. If a lost/stolen credential is presented to the reader, access shall be denied, an alarm shall be transmitted within the system requiring acknowledgement from security personnel.
  - 6. Forced entry detection shall be enabled at doors equipped with an internal request to exit (REX). A forced entry shall be generated immediately whenever the door is opened without authorization. Authorization shall be determined by card, REX transaction at the door, or by command from the host system as described. Doors without an internal REX device shall not report forced entry.
  - 7. Door held open detection shall be enabled at electronic controlled doors. A door held open event shall be generated immediately when the door is held open longer than 30 seconds.
  - 8. System shall automatically re-lock the electronic controlled portal when the door is sensed as closed and/or whenever the 2 second door relay unlock time expires.
  - 9. Auto operator motor (ADA button) shall be disabled when the door hardware is in a locked state from the outside without an authorized credential read. Interior ADA button shall always be enabled to operate and unlock the door hardware if the door is in a locked state. When an authorized credential is presented to the exterior card reader the access control panel/relay shall unlock the door enable the auto operator button allowing the motor to open the door.
  - 10. Door entry and remote handset station shall have default passwords changed. Current firmware shall be uploaded. Handset station shall have apps and Wi-Fi disabled.

11. When a panel/power supply is opened, a tamper event shall be generated immediately.
12. System shall send an alarm of any communication failures with the ACPs or the communication application.
13. Other programming requirements shall be coordinated with the Owner and shall be provided at no additional cost to Owner. Coordinate with Owner for required business hours.
14. Door 100A shall be unlocked during business hours. It shall lock after business hours.
15. Door 100C shall be locked at all times and shall unlock on valid credential read or by a door release button at the reception desk.
16. All other openings shall open only upon a valid credential read.

B. System Integration:

1. Access Control and IP Security Video Integration
  - a. Cameras near entry locations shall be linked via API hooks to the access control system to record card access entry into the facility.
    - 1) Coordinate API hooks to IP security video system.
    - 2) Coordinate directly with the IP security video system installer to ensure complete and fully functional programming.

3.06 **PRE-TESTING**

- A. After Work is completed, and prior to requesting the acceptance test, Contractor shall conduct a final inspection, and an operational pre-test of all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and operational pre-test.
- B. Submit written notification to the Owner's Representative and the A/E that systems have been tested, are operating properly, and are ready for Acceptance at least 21 days prior to the requested test date.

3.07 **FINAL ACCEPTANCE**

- A. Contractor shall submit a request for the Acceptance test in writing to the Owner no less than twenty-one days prior to the requested test date. The request for acceptance test shall constitute a certification from the Contractor that all Work is complete and in compliance with the Contract Documents; all systems have been tested; and that all corrections have been made.
- B. Acceptance test shall be scheduled during a period when the building is unoccupied and a complete system test can be accomplished. Contractor shall provide the services of no fewer than two (2) technicians to perform the acceptance test. Technicians performing the acceptance test shall have been involved in the installation of this project and shall be thoroughly familiar with all aspects of the Work. Technicians shall be equipped with portable two-way radios that will be used during the test.
- C. Contractor shall provide all ladders, tools, test equipment, and other facilities needed to accomplish the Acceptance test.

- D. During acceptance test, Contractor shall demonstrate all equipment and system features to the Owner. Contractor shall fully cooperate with the Owner and provide assistance with the inspection and test. Contractor shall remove and reinstall covers, open and restore wiring connections, operate equipment, and perform other reasonable work as requested by the Owner.
- E. Any portions of the Work found to be deficient or not in compliance with the Contract Documents will be rejected. Owner will record any such deficiencies observed during the Acceptance test. A copy of said list will be provided to Contractor. Contractor shall promptly correct all deficiencies.

**3.08 WARRANTY AND SERVICE**

- A. Contractor shall provide parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of one (1) year from Date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.
- B. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

**3.09 TRAINING**

- A. Owner shall receive 4 hours of instruction in (2) 2-hour segments covering all aspects of operating the access control system.
- B. Owner shall also receive assistance in configuring and inputting database to the Owner's satisfaction and until initial database is complete and functional.

\*\*\* END OF SECTION \*\*\*

**SECTION 28 31 11**  
**FIRE ALARM AND DETECTION SYSTEMS**

**PART 1 - PRODUCTS**

**1.01 MANUFACTURERS**

- A. Description: Design, furnish, install, and connect analog addressable, intelligent fire alarm and detection system with emergency voice/alarm communication required to form a complete coordinated system ready for operation. It shall include, but not be limited to, initiating devices, alarm notification appliances, control panels, annunciators, auxiliary control devices, power supplies, batteries, wiring and ancillary devices as shown on the Contract Drawings, as specified herein or as required to meet AHJ requirements. Contract Drawings and Specifications indicate minimum system requirements. This is a bidder-designed system and it is the responsibility of the fire alarm system vendor to provide an AHJ approved system and design, Preferred manufacturer Honeywell, provide alternate pricing for Notifier, Simplex Grinnell, Edwards/EST.
- B. Fire Alarm System design shall be done under separate permit documents. Fire Alarm Design/Build contractor shall be responsible for shop drawings, point to point wiring diagrams, voltage drop calculations, battery calculations, device locations, interlock wiring and monitoring of duct smoke detectors and fire/smoke dampers, interlock with the Landlord Fire Alarm System if applicable, and submittal to Fire Marshall for approval.
- C. Fire Alarm Bidder Design subcontractor shall provide system design and device layout in compliance with code and jurisdictional requirements.
- D. Fire Alarm Bidder Design subcontractor shall confirm the scope of work with landlord and jurisdiction prior to bid and shall include all costs necessary to comply with the required design in bid.
- E. Fire Alarm Bidder Design subcontractor shall refer to the mechanical HVAC plans for this project and verify the quantity and location of all duct smoke detectors required for the HVAC ductwork system. The Fire Alarm Bidder Design subcontractor shall provide all duct detectors and connections required.

**1.02 FIRE ALARM AND DETECTION SYSTEMS**

- A. General: Electrically operated, electrically supervised, fire alarm and detection system as described herein. Include control units, power supplies, alarm initiating and indicating devices, conduit, wire, fittings, and accessories required for a complete operating system.
- B. Comply with requirements in Section 260533 for raceways, Section 260519 for conductors, Section 260534 for outlet boxes, and Section 260529 for supports. Minimum wire size No. 16 AWG for initiating circuits and No. 14 AWG for indicating circuits.
- C. Open cabling methods may be utilized above accessible ceilings. All cabling in exposed areas, above inaccessible ceilings and in walls shall be installed in raceway.
- D. Notification Appliance and Signaling Line Circuits: NFPA 72, Class B.

- E. Install no more than 100 addressable devices on each signaling line circuit. Provide isolation modules on signaling line circuits: 1) on each floor where serving multiple floors, and 2) so no more than 50 addressable devices can be out of service due to a single wiring fault

1.03 **SUBMITTALS**

- A. Comply with requirements in Division 01 and Section 260500.
- B. Installer Qualifications.
- C. Detailed description of equipment anchorage devices on which certification is based and their installation requirements. Sequence of Operation Matrix: Provide a sequence of operation matrix which includes all trouble, supervisory and alarm conditions monitored by the system. The matrix shall be included in the shop drawing set. Provide written sequence of operation that describes the interlocks between the Fire Alarm system and all other building systems (Fire suppression, HVAC, Access Control, etc.).
- D. Product Data: Submit manufacturer's technical product data for fire alarm and detection systems components including, but not limited to, roughing-in diagrams and instructions for installation, operation, and maintenance, suitable for inclusion in the Maintenance and Operation Manuals. Include riser and wiring diagrams for panel and system components.
- E. Shop Drawings: Indicate equipment and device locations and connecting wiring of entire fire alarm and detection system. Include layout wiring and riser diagrams, point-to-point diagrams, and floor plans with notification appliances, raceways and wiring routing, including device addresses and strobe candela ratings. When system has Emergency Voice Communication for an Alerting system, also include Acoustical Distinguishable Space (ADS) assignments/classifications for all areas in the building per NFPA 72. as well as speaker placement, speaker sound level output, Seismic mounting supports and locations of ACU's and LOC's.
- F. Details and schedules to include:
  - 1. Battery Calculations.
  - 2. Notification Appliance Circuit Calculations and Loads.
  - 3. Strobe Circuit Voltage Drops.
  - 4. Notification Appliance Circuit Schedules.
  - 5. Symbol Legend and Wiring Code (per manufacturer's requirements).
  - 6. I/O Point and Relay Schedules.
  - 7. Typical Wiring Diagrams indicating connections between panel modules and field devices and auxiliary interfaces (i.e. elevator controls, fire doors, etc.).
- G. Acceptance Test Procedure: Submit a written Acceptance Test Procedure (ATP), approved by the AHJ, to Engineer at least thirty days prior to scheduled testing. The ATP shall include step-by-step procedures for performance testing every fire alarm device and system output to demonstrate functionality in accordance with specification requirements.
- H. Acoustical Acceptance Test Procedure: Submit a written Test Procedure to be approved by the Owner/Engineer. Test procedure shall identify the different acoustical distinguishable space assignments/classifications and how each will be tested to meet the minimum requirements for Speech Transmission Index (STI) of 0.50 STI. Provide testing equipment documentation.

1. Testing Product Data. Submit technical product data for the sound testing equipment to be used during testing and commissioning. Equipment shall be capable of testing STI and CIS scores using the STIPA Test Signal to 0.01.
- I. Test Reports:
    1. Field test reports.
    2. Acoustical test reports.
    3. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.
  - J. Obtain from each AHJ written certification that the permanent installation has been inspected and that it complies with AHJs' published regulations and requirements. Submit prior to Substantial Completion.
  - K. Operation and Maintenance Data: Comply with requirements in Section 260500. In addition, include the following:
    1. Prepare complete, simple, understandable, step-by-step, testing instructions with recommended and required testing frequency of equipment with methods for testing equipment. Include trouble-shooting manual.
    2. Prepare complete, easy-to-read, understandable maintenance instructions including the following information:
      - a. Instruction on replacing components of system including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.
      - b. List of equipment and components with address and phone number of both manufacturer and local supplier of each item.
    3. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
    4. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
    5. Record copy of site-specific software.
    6. Submit minimum one week prior to system training.
  - L. Instruction Card: Provide a computer-generated instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Card must indicate those steps to be taken by an operator when a signal is received as well as functional operation of system under all conditions: normal, alarm, supervisory, and trouble.

**1.04 SYSTEM DESIGN CRITERIA (BIDDER DESIGN)**

- A. Design, furnish, and install complete operable fire alarm and detection systems in accordance with the latest adopted editions of IBC, IFC, NFPA 72, and applicable city, county, and state laws, codes, and standards.
- B. The Contractor's scope of work shall include but not limited to the following:
  1. Complete fire alarm system based on the available architectural, civil, structural, mechanical and electrical drawings. Devices shown on drawings do not reflect



complete system. Provide additional devices, conduit, wire and programming for a complete and operable system as required by AHJ.

2. Wiring systems associated with fire alarm system.
3. Provide additional smoke detectors, heat detectors, manual alarm stations, horns, visual notification appliances, speaker notification appliances, bells, door holder controls, fire shutter and fire curtain controls, panels, power supplies, and control graphic annunciators associated with fire alarm system.
4. Provide auxiliary controls and switches including interposing control, monitor relays, and interconnection coordination for monitoring of fire sprinkler system tamper, flow and pressure switches, mechanical equipment shutdown and smoke and combination fire/smoke damper controls, elevator controls, smoke evacuation controls, area pressurization controls.
5. Provide interconnection for monitoring of fire suppression releasing panels and controls provided by Division 21.
6. Audibility and Intelligibility requirements shall meet NFPA 72 and contractor shall provide bypass for any devices near manual microphone stations as required to support audibility and eliminate any feedback on the system.

#### 1.05 SYSTEM TYPE

- A. Low voltage, point identification fire management system. Fire alarm and detection system shall monitor intelligent (analog) and addressable (digital) devices, traditional initiating devices, point identify alarm location, and transmit signals to monitoring agency.
- B. Fire alarm control panel shall allow for loading or editing special instructions and operating sequences. System capable of on-site programming to accommodate and facilitate expansion, building parameter changes, and changes as required by AHJs. Software operations stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions stored in memory.
- C. Emergency voice communication control panel shall provide for one-way voice communications, routing and pre-amplification of digital alarm tones and voice (digital and analog) messages. Automatic pre-recorded messages and live messages shall be broadcast through speakers. Live messages shall override the automatic messages and tones. Voice messages shall be developed based upon input from AHJ.

#### 1.06 FIRE ALARM NETWORK

- A. High Speed Network Communication.
  1. The high speed network architecture shall be through a token ring, hub, or star topology configuration, or combination thereof. A single open, ground or short on the network communication loop shall not degrade network communications. Token shall be passed in opposite direction to maintain communications throughout all network nodes. At the same time the status of the communication link shall be reported. If a group of nodes becomes isolated from the rest of the network due to multiple fault conditions, that group shall automatically form a sub-network with all common interaction of monitoring and control remaining intact. The network shall be notified with exact details of the lost communications.. A node may be an intelligent Fire Alarm Control Panel, Network Workstation or Network Annunciator.
  2. The network shall provide communications for single channel digital voice and telephone as well as panel to panel communications on the same optical fiber network media.
  3. The network shall be capable of expansion to at least 99 nodes.

4. Each network shall have the capability of communicating with two node addresses simultaneously.
5. The network shall provide a connection point for network upload/ download of panel application software and panel database configurations while nodes on the network are in service.
6. Network upload/download shall support broadcast and point to point operation.
7. Each network node address shall be capable of storing event equations. The event equations shall be used to activate outputs on one network node from inputs on other network nodes.
8. The Network shall utilize an IP based Ethernet technology.
9. The network shall communicate via fiber optic medium. The Network shall be compatible with multimode and single mode fiber optic media without the use of external converters.
10. The Network shall operate as a Style 7 network.
11. Provide a network interface in every fire alarm control panel.
12. The high speed network interface shall function as a network repeater to increase the fiber optic distance in dB increments stated in this specification.
13. Fiber Optic Network Communication:
  - a. Optical fiber cabling in accordance with Section 271100 "Telecommunications System". Cabling shall meet fire alarm manufacturer requirements.
  - b. Cabling jumpers shall be dedicated for the fire alarm system with an overall red sheath.

#### 1.07 SYSTEM OPERATION

- A. Alarm displayed on an 80 character alphanumeric display and on remote printer. Top line of characters shall be point label and second line shall be device type identifier. System alarm red LED shall flash on control panel and remote annunciator shall indicate specific device in alarm. Subsequent alarm received from another zone after being acknowledged shall flash system alarm LED on control panel and remote annunciator. LCD display and printer shall show new alarm information. Alarm tone shall occur within control panel and remote annunciator until acknowledged.
- B. Alarm indicating devices silenced by entering locked control cabinet and operating alarm silence switch. Subsequent alarm condition shall reactivate signals.
- C. Activation of any system smoke detector shall initiate an alarm. Alarm verification operation shall be programmed into the system for future use but not active until approved by AHJ. Alarm verification function: control panel shall reset activated detector and wait for second alarm activation. If, within 1 minute after resetting, second alarm is reported from same or any other smoke detector, system shall process alarm as described previously. Time period for alarm verification reset programmable from 0 to 60 seconds. If no second alarm occurs within alarm verification time window, system shall resume normal operation. Alarm verification shall operate only on smoke detector alarms. Other activated initiating devices process immediately. Alarm verification operation selectable by device, not just by zone. Control panel with capability to display number of times zone or detector has gone into verification mode. Information displayed on control panel and transmitted to remote printer and remote annunciator.
- D. Control panel shall have a dedicated supervisory trouble condition indicator and acknowledge switch.

1. Activation of any standpipe or sprinkler valve tamper switch shall activate system supervisory service audible signal and illuminate LED at control panel and remote annunciator. Include differentiation between valve tamper activation and open circuits or ground conditions.
  2. Activating acknowledge switch shall silence audible signal while supervisory service LED.
  3. Restoring valve to normal position shall cause supervisory service LED to extinguish thus indicating restoration to normal position.
- E. Include manual evacuation switch at control panel to operate systems alarm indicating devices. Other control circuits not activated. True alarm processed as described previously.
- F. Alarm and trouble conditions displayed on control panel from alphanumeric display, at remote printer, and at remote annunciator. If more than one alarm or trouble is initiated, operator may scroll to display new alarms.
- G. Control panel capable of supplying minimum 6 Amps at 24 VDC, filtered and regulated. Power supply expandable to total ampacity required by system. Initial system shall include a minimum of 25% spare capacity.
- H. Functions of control panel field programmable.
- I. Include connection to fire sprinkler system tamper switches, flow switches and high/low air pressure alarm switches. Include connection to tamper switches in exterior vaults and post indicator valves as required.
- J. Include elevator fire alarm control.
- K. Include connection to kitchen hood fire alarm system.
- L. Include connection from duct smoke detector relay to fan starter control circuit. Fans shut down on local detection only. Provide interposing relays as required for HVAC shutdown. Coordinate requirements with mechanical contractor and equipment vendor.
- M. Include connection to smoke dampers and combination fire/smoke dampers. Dampers close upon activation of smoke detectors in adjacent areas or adjacent duct detection. Include interface relay.
- N. Include fire alarm system power and fire closure signal connection to fire shutters in corridors. Shutters powered from fire alarm panel. Shutters close on local detection only. Coordinate requirements with shutter supplier.
- O. Include fire alarm system power and general alarm release signal for magnetic door holders. Coordinate requirements with door hardware supplier.
- P. Include system output relay for alarm signaling to mechanical control system specified in Division 23.

#### 1.08 POWER REQUIREMENTS

- A. Include 120 VAC power from dedicated circuit for control panel.
- B. Include sufficient battery capacity to operate entire system upon loss of normal 120 VAC power in normal supervisory mode for a period of 60 hours with 15 minutes of alarm

operation at end of this period. System shall automatically transfer to standby batteries upon power failure. Battery charging and recharging operations shall be automatic.

- C. Circuits requiring system operating power shall be 24 VDC. Include individual fuses at control panel.

#### 1.09 EQUIPMENT

- A. Fire Alarm Control Panel: Modular construction with solid state microprocessor based electronics with a minimum of 25 percent spare point capacity. Include minimum 80 character minimum alphanumeric display to indicate alarms, supervisory service conditions, and troubles.

- B. Control panel shall include the following:

1. 80 character LCD display.
2. Minimum of 2 indicating appliance circuits.
3. Non-volatile EEPROM memory.
4. Multiple password levels.
5. RS232 port for programming and printer and video display unit input/output.
6. Logic Statements.
7. Time Controls.
8. Sequences.
9. Actions.
10. Reporting of all sensors and zones.
11. Sensitivity setting by sensor (within UL Limits).
12. Alarm verification by point or zone.
13. Enabling and disabling of any system device or function.
14. Ground fault detection on all system devices and inputs.
15. Normal and silent walk tests.
16. Cards, Components, Amplifiers etc. as required to support peripheral devices on the system.

- C. Programming:

1. Programming accomplished using a standard IBM compatible computer, either desk or laptop.
2. Resident program stored in non-volatile EEPROM memory.
3. System with capability to store system program on a hard disk for future changes, upgrades, and replacement.
4. Software to allow user to reprogram system points, add system points, add or change point descriptions, and update data file. System output functions field programmable to allow custom operation.

- D. Printer: Black and white laser printer to record trouble and alarm signals and programmable changes.

#### 1.10 PERIPHERAL DEVICES

- A. Manual Stations: Constructed of red Lexan with raised white lettering. When station is operated, handle shall lock in protruding manner to facilitate quick visual identification of activated station. Station capable of being reset using a key. Stations which require only a screwdriver for operation not acceptable.

- B. Manual Station Guards: Plastic guards with built-in independent local alarm. Stopper Two or approved. Provide on all manual pull stations unless otherwise noted.
- C. Smoke Detectors:
1. General: UL 268 listed and documented compatible with control equipment to which it is connected. Photoelectric type, unless indicated otherwise, with a plug-in base and visual indication of detector actuation. Detectors intelligent, addressable and with capability of alarm verification, sensitivity adjustment by detector, and “maintenance alert” circuitry. Integral addressable module.
  2. Duct Smoke Detectors: UL 268A listed.
    - a. Capable of operating in air velocity range of 300 to 2,000 feet per minute.
    - b. Detectors with approved duct housing for mounting exterior to duct. Weatherproof housing for exterior locations.
    - c. Perforated sampling tubes extending across width of duct and end support.
    - d. Integral filter system air flow monitor to indicate presence and direction of air flow through detector.
    - e. Control modules and relay(s) required for equipment shutdown circuit and connection to control system. Coordinate interface with mechanical equipment and controls.
    - f. Where duct smoke detector is installed above a ceiling, include remote indicator lamp and magnet activated test switch mounted on ceiling below unit. Label remote lamp and test switch. Furnish test magnet to Owner.
    - g. Nameplate indicating corresponding mechanical equipment name and “supply air” or “return air”, as applicable.
- D. Heat Detectors: Addressable, analog thermal detectors. Rate of rise feature accomplished with electronic, dual thermistors. Include built-in test switch and LEDs to indicate alarm condition and polling. Thermal head shall plug-in to base. Heat detector rated for the environment in which it is to be installed (135° typical).
- E. Heat Detectors, Weatherproof: Automatic resetting rate of rise type suitable for exterior installation. Include addressable module. Temperature rating as required by the installation, 135° F minimum. Fenwal horizontal Detect-A-Fire Series or approved equal.
- F. Single Temperature Linear Heat Detection Cable:
1. The Linear Heat Detection Cable shall be a fixed temperature sensing element comprised of two electrical current carrying wires separated by a heat sensitive insulation material.
  2. The detection cable shall detect the specified temperature anywhere along the detector length, regardless of the source of the heat. Averaging, analog-integrating, or thermistor-type detection cables, and rate compensated, or rate-of-rise detection devices, are not acceptable.
  3. Detectors that depend on open flame, density of smoke, or rate of temperature increase are not acceptable.
  4. The detection cable shall be constructed by spiral wrapping the two conductors with a protective mylar tape and then wrapping them in protective outer coverings of cotton braid, PVC, or weather resistant Nylon as required for the intended environment. The detection cable shall be capable of withstanding severe seasonal temperature variations and structural vibrations.

- a. The temperature rating of the detection cable shall be clearly printed on the cable jacket.
  5. When the detection cable will be required to span distances in excess of the manufacturer's standard mounting guidelines, it shall be constructed with an integral messenger wire. The messenger wire shall consist of a high tensile strength corrosion-resistant steel wire which shall be wrapped around the detection cable at a minimum rate of one turn per linear foot of cable length.
  6. The initiating circuits shall be capable of intrinsically safe service and approved for Class I, II, or III, Div. 1, 2, or 3, and applicable groups A, B, C, D, E, F, & G.
  7. The detector shall withstand gamma radiation at the rate of  $3.6 \times 10^5$  Rad/hour without insulation breakdown.
  8. The detection cable shall be available in several temperature settings to allow for different ambient space temperature ranges and alarm points.
  9. The detection cable temperature ranges shall be selected for the expected maximum ambient temperature and the alarm activation temperature suitable for the application in accordance with the Manufacturer's guidelines.
  10. Detection cables of different temperature ratings shall have the ability to be easily spliced together in series without affecting the adjacent detector alarm point.
  11. Acceptable Manufacturers of the electronic fire detection, alarm, and control equipment are: The Protectowire Company, Inc., Hanover, Massachusetts 02339, USA, 781-826-3878.
- G. Primary Notification Appliances: Provide flush mounted combination horn/strobe Audio/Visual signaling appliances where required. Specific audible and visual characteristics shall be as follows:
1. Visual Signals Fire Alarm: Furnish and install xenon strobes, synchronized in accordance with NFPA 72 chapter 4 and rated to UL 1971 standards. Strobes shall have a fixed candela rating, as follows: provide 15 candela in corridors and other areas up to 20' x 20', 75 candela in areas up to 40' x 40', and 110 candela in areas up to 50' x 50'.
  2. Audible Signals: Provide audible signal appliances designed to produce a minimum sound output of 85 dbA at 10', or 15 dbA above ambient; whichever is greater.
  3. Audible Signals: Provide High Fidelity audible signal appliances designed to produce a minimum sound output of 85 dbA at 10', or 15 dbA above ambient; whichever is greater. Speakers shall have field selectable output tap from 0.5 to 2.0 Watts. Initial circuiting design shall be sized at 1.5 Watts per speaker for base design.
  4. Power Supplies: The power supplies provided for the system shall be capable of powering all notification devices simultaneously with a minimum of 20% spare capacity. Provide power supplies in increments of 8 Amps. Supervision of power supplies shall be integral to the panel. The need for separate monitor modules to supervise power supplies are not acceptable.
- H. Prerecorded Message Devices:
1. One-way, multichannel voice notification system incorporating no fewer than eight distinct sounds selectable by user for tone signaling and incorporating a voice module for delivery of prerecorded or live messages.
  2. Audible appliances must produce an initial message stating "May I have your attention please?" followed by a voice message with instructions for "Evacuation", "Shelter in Place" or as defined by the Designer of Record and the AHJ that is repeated until ACU is reset or silenced. If the intent is for building or floor evacuation, the standard temporal pattern complying with ASA S3.41 will follow the message.

3. Automatic messages must be broadcast through loudspeakers throughout the building or facility, but not in stairs or elevators.
  4. When using microphones, live messages must be broadcast throughout a selected floor or floors or all call, including stairs and elevators.
  5. Loudspeakers must not be installed in near a microphone that will be used for live messaging.
- I. Live voice message must override automatic or recorded audible output through use of a microphone input at ACU or the remote cabinet
- J. Multiple strobes visible in a single room coordinated to flash simultaneously.
- K. Water Flow Switches: Provided by Division 21 and wired by Divisions 26, 27, and 28. Coordinate requirements.
- L. Sprinkler Valve Tamper Switches: Provided by Division 21 and wired by Divisions 26, 27, and 28. Coordinate requirements.
- M. Magnetic Door Holders: Provide by General and wired by Divisions 26, 27, and 28. Holders shall be powered from the fire alarm system. Coordinate requirements.
- N. Provide Remote LCD Annunciators. The main office Remote Annunciator shall be LCD type with key activated controls to allow silencing, resetting and activating of alarms. The Fire Department remote annunciator shall have a LCD readout and adjacent building map to direct fire fighters to source of alarm. Wording on map shall reflect information on digital readout. Communication between the main fire alarm control panel and the remote annunciators shall be via an RS232 link. A graphic map shall be provided adjacent to the remote LCD annunciator.
- O. Provide Graphic map. The Graphic map shall be a floor plan representation of the facility and shall be a full color image printed on the reverse side of 10 mil. Polycarbonate Lexan. The printed image shall be laminated to a 1/8" rigid backing with a removable adhesive for future replacement. The graphic map shall be secured in a black (standard) anodized aluminum frame and mounted with a concealed security hanging system to prevent any unauthorized removal. Obtain approval of graphic map from AHJ. Graphic map shall include the following:
1. Clearly legible room names and numbers for all floors of the building.
  2. Location of the Annunciator indicated with "You are Here" notation.
  3. Location of the Fire Alarm Panel.
  4. Location of Sprinkler Valve Riser Room (if available).
  5. Location of the Mechanical Room.
  6. Location of Electrical Room.
  7. Locations and zone numbers of Areas of Evacuation Assistance.
- P. IP Communicator:
1. Manufacturer: Notifier IPDACT-2UD, no substitutions.
  2. The IP Communicator shall be UL 864 listed for signaling under Other Transmission Technologies and comply with NFPA 72 requirements.
  3. The IP Communicator shall be capable of using low-cost, non-analog, digital telephone services such as cable or fiber optics.
  4. The IP Communicator shall not require change to the existing panel configuration. The IP Communicator must connect directly to the primary and secondary analog panel telephone ports.



5. The IP Communicator shall work over any type of customer-provided Ethernet 10/100 Base network connection (LAN or WAN), DSL modem or cable modem.
  6. Data transmits over standard contact-ID protocol must be secured with the industry's highest level of encryption (AES 512 bit).
  7. The IP Communicator shall support both dynamic (DHCP) or Public and Private Static IP addressing.
  8. The IP Communicator shall support dual-destination IP receiver address for high redundancy configurations. All signals are sent to a secondary address should the primary become unavailable.
  9. Provide user programmable UDP ports for flexibility and compatibility with firewalls and other network security components.
  10. The IP Communicator shall be compatible with the following UL 864 Ninth Edition fire alarm panels: NFS-320, NFS2-640, and the NFS2-3030.
  11. Provide installation, programming and testing in strict compliance with the manufacturer's direction.
  12. Communicator shall send signals to the required monitoring agency.
  13. Provide communicator programming hardware, software and services for contact ID reporting as requested by the Owner and AHJ.
  14. Owner's selected alarm company shall be present during dialer programming.
- Q. Documentation Cabinet: Provide cabinet sized so that it can contain all necessary documentation. Cabinet shall be prominently labeled "System Record Documents".

\*\*\* END OF SECTION \*\*\*



**SECTION 31 20 00  
EARTH MOVING**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

- A. Provide excavation, subgrade preparation, fill, compaction, and site grading for paved areas, structures, and landscaped areas. Placement of planting media is not included in this Section. Rough grading and all fine grading to complete this project are included in this specification.

**1.02 REFERENCES**

- A. AASHTO T180 - Moisture-Density Relations of Soils Using a 10 lb (4.54 kg) Rammer and an 18 in. (457 mm) Drop.
- B. WSDOT-APWA - 1994 Standard Specifications for Road, Bridge, and Municipal Construction (not including measurement and payment provisions).
- C. WSDOT-APWA - Standard Plans for Road, Bridge and Municipal Construction.
- D. Pierce County - Site Development Regulations, ORD. 90-132.
- E. ASTM C136 - Method For Sieve Analysis of Fine and Coarse Aggregates.
- F. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 in. (304.8 mm) Drop.
- G. ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- H. ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 in. (457 mm) Drop.

**1.03 QUALITY ASSURANCE**

- A. All work shall be in accordance with the WSDOT-APWA Standard Specifications for Road, Bridge and Municipal Construction, including APWA supplements, unless modified herein or on the drawings.
- B. Testing:
  - 1. Notify Architect and Soils Engineer a minimum of twenty-four (24) hours prior to proof-rolling of subgrade for evaluation of subgrades by the Soils Engineer.
  - 2. Testing of compacted subgrade and fill materials will be performed by an independent testing laboratory appointed and paid for by the Owner. Testing will be performed so as to least encumber the performance of Work.
  - 3. The Owner will pay for the cost of one (1) series of tests only, on the area being evaluated. Contractor shall pay for costs of additional site visits and testing required due to improper performance and scheduling of Work.
  - 4. When Work of this Section or portions of Work are completed, notify the testing

laboratory to perform density tests.

5. If during progress of Work, tests indicate that compacted materials do not meet specified requirements, remove defective Work, replace, and retest at no cost to Owner.
6. Ensure compacted fills are tested before proceeding with placement of surface materials.

#### 1.04 SUBMITTALS

- A. Submit samples and test results for acceptance of imported materials to Architect.
- B. Test Results: Test results for "in place" materials shall be sent directly, by the Owner's testing laboratory, to the Engineer and the Architect.

#### 1.05 IMPORTED MATERIAL ACCEPTANCE

- A. All imported materials specified in this Section are subject to the following requirements.
  1. All work necessary for the Contractor to locate an acceptable source of imported material shall be made by the Contractor.
  2. Owner will provide commercial testing laboratory for certification as to whether the material conforms to the Specification or not.
  3. Requests by Contractor for testing shall be submitted to the Owner at least five (5) days before the material is required for use.
  4. All material samples shall be furnished by the Contractor at the Contractor's sole expense. Samples shall be representative and clearly marked to show the source of the material and the intended use on the project. Sampling of the material source shall be done by the Contractor in accordance with ASTM D75.
  5. Notify the Engineer at least twenty-four (24) hours prior to sampling. The Engineer may, at the Engineer's option, observe the sampling procedures. Tentative acceptance of the material source shall be based on an inspection of the source by the Owner's testing laboratory personnel.
  6. No imported materials shall be delivered to the site until the proposed source and materials tests have been accepted in writing by the Owner's Testing Laboratory.
  7. Final acceptance on site will be based on tests made on samples of material taken from the completed and compacted course. The completed course is defined as a course or layer that is ready for the next layer or the next phase of construction.
- B. If tests indicate that the material does not meet Specification requirements, material placement will be terminated until corrective measures are taken. Material that does not conform to the Specification requirements and is placed in the Work shall be removed and replaced at the Contractor's sole expense.

#### 1.06 SITE COMPACTION TESTING

- A. Testing:
  1. Testing of compacted fill materials will be performed by an independent testing laboratory appointed and paid for by the Owner. Testing will be performed so as to

least encumber the performance of Work. Notify Owner's Testing Laboratory forty-eight (48) hours before testing is needed.

2. When Work of this Section or portions of Work are completed, notify the Owner's Testing Laboratory to perform density tests.
3. If, during progress of Work, tests indicate that compacted materials do not meet specified requirements, remove defective work, replace and retest at no cost to Owner.
4. Tests will be taken by the Owner's Testing Laboratory as often as needed to certify the Contractor's work. Any work or materials later discovered to be defective shall remain the Contractor's responsibility whether or not the Owner's Testing Laboratory has tested the area.

#### 1.07 SUBSURFACE SOILS DATA

- A. *[Data concerning subsurface materials or conditions is based only upon test pits, which was obtained by Owner under a separate soils investigation contract for the original building that now exists. This data was turned over to the Architect for his own use in designing the project. Its accuracy or completeness of the soils report is not guaranteed by the Owner or Engineer and in no event is it to be considered a part of the Contract Documents. Contractor must assume all responsibility in excavating for this project and shall not rely on subsurface information obtained from Engineer, or indirectly from Owner. Owner or Engineer shall not be responsible for additional compensation for excavation work performed under the Contract due to Contractor's assumptions based on subsoil data prepared solely for Engineer's use.]*
- B. Subsurface soils data is included with the Contract Documents. Owner, Architect, and Engineer are not responsible as to its accuracy or completeness or for any additional compensation for work performed under the Contract due to assumptions based on use of such reviewed information.

#### 1.08 DIMENSIONS AND LAYOUTS

- A. The Contractor will be responsible for furnishing, setting, and marking all line, grade, and location stakes, including offsets and general construction staking.
- B. There shall be on site at all times when Work requiring control is being performed all necessary equipment, supplies, and instruments related thereto. A qualified layout engineer, or licensed surveyor must be assigned to the Contractor's crew for this Work. This equipment and personnel must be available at no additional cost to the Owner for the purpose of verifying layout and certifying the accuracy of Work placement and grading on the site.
- C. The Contractor is responsible for preserving all benchmarks and stakes and the replacement of any that are displaced or missing.

#### 1.09 UNIT PRICES

- A. Provide unit cost per cubic yard of excavation for changing quantities of Work by adding to or subtracting from Base Bid for over excavation and removal of unsuitable soils below subgrade that is to support foundations, slabs, structural fill, and/or pavement. Refer to and include cost on Proposal Form.
- B. Provide unit cost per cubic yard of imported structural fill in place for changing quantities of Work by adding to or subtracting from Base Bid for over excavated areas resulting from removal of unsuitable soils below subgrade that is to support foundations, slabs, structural fill, and/or pavement. Refer to and include cost on Proposal Form.

1.10 ALTERNATES

- A. See Section 01 23 00 for bidding alternates affecting the Work of this Section.

PART 2 - PRODUCTS

2.01 STRUCTURAL FILL

- A. All fill placed under or around walls, under slab-on-grade floor, roadways, parking lots, sidewalks, and on-grade ramps and stairs, for all other paved areas, and for backfill of utility trenches shall be "structural fill" as defined herein.
- B. Structural fill shall be imported clean granular fill or on-site material that has been accepted by the Soils Engineer for use as structural fill.

1. Imported structural fill shall consist of well-graded sand and gravel materials free of organic material, debris, and other deleterious material, and shall conform to the following gradation requirements:

<u>Standard Sieve Size</u>	<u>Percent Passing by Dry Weight</u>
inch	100
No. 4	25 - 75
No. 200	5 maximum of that portion passing the 3/4 in. sieve.

2. On-site material used for structural fill shall be the non-organic site soils, which shall consist of primarily silty sands, free of organic and other deleterious materials, shall contain no particle greater than 6 in., and is suitable for use only in the dry summer months. Prior to placement as fill, this material shall be excavated and processed by cleaning, aeration, and drying as required by the Soils Engineer, who shall periodically observe and make recommendations regarding the excavation and fill work.
- C. Structural Fill Under Slab: Fill material placed below the capillary break may be imported granular fill or, provided that soil moisture can be reduced and maintained near optimum, may be excavated on-site natural sand soils. Existing soils which contain organic materials and natural or fill soils which contain clay are unsuitable for use under structures.
- D. Approval of Fill Material: All material that is proposed to be used as fill shall be graded and tested for moisture content and compactability. Gradation and test results shall be submitted for review and approved by the Soils Engineer prior to placement of fill.
- E. Fill placed at locations other than those requiring structural fill, where the purpose is to raise site grades, shall be "common fill" as defined herein: Common fill shall be imported or excavated on-site material and shall consist of granular soils essentially cleaned of organic and other deleterious material and of such particle size and gradation that specified compaction can be readily attained. The moisture content of common fill material at placement and compaction shall be within a range of 1 percent above to 2 percent below optimum moisture content. Common fill, whether excavated on site or imported, shall be tested and approved by the Soils Engineer prior to use.

2.02 CAPILLARY BREAK

- A. 3/8 in. pea gravel.

**2.03 BACKFILL FOR PIPE FOUNDATION**

- A. Gravel backfill for pipe foundation shall consist of crushed, processed, or naturally occurring granular material. It shall be essentially free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact readily and shall meet the following specifications for grading and quality.

<u>Sieve Size</u>	<u>Percent Passing</u>
1 in. square	100
1/4 in. square	25-80
U.S. No. 200	15.0 max.
Sand Equivalent	35 min.

All percentages are by weight.

**2.04 BACKFILL FOR PIPE BEDDING**

- A. Rigid Pipe Bedding:

1. Crushed, processed, or naturally occurring granular material. It shall be essentially free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact readily and shall meet the following specifications for grading and quality:

<u>Sieve Size</u>	<u>Percent Passing</u>
square	100
square	25-80
No. 200	15.0 max.
Sand Equivalent	35 min.

All percentages are by weight.

- B. Flexible Pipe Bedding: Clean sand/gravel mixture free from organic matter and conforming to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4 in. square	100
3/8 in. square	70-100
U.S. No. 4	55 - 100
U.S. No. 10	35-95
U.S. No. 20	20-80
U.S. No. 40	10-55
U.S. No. 100	0-10
U.S. No. 200	0-3

All percentages are by weight.

**2.05 TRENCH BACKFILL**

- A. Trench backfill material shall be structural fill as described in this Section.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Establish and identify required lines, levels, contours, and datum using a Washington licensed professional land surveyor employed by Contractor.
- B. Maintain benchmarks, monuments, and other reference points. Re-establish if disturbed or destroyed, at no additional cost to the Owner by a Washington licensed professional land surveyor.
- C. Before start of grading, establish the location and extent of existing utilities in the Work area to the fullest extent possible using locator services.
- D. Many utilities are known to exist on the site. Many of these have already been field located and are shown on the Plans. Contractor is, however, responsible for the protection of all locatable utilities.
- E. Do not perform cut and fill work in weather that will not allow working of site soils. Use no frozen material in fills.
- F. Use normal construction methods generally, but if weather will not allow working of site soils, use wet weather methods as noted below at no additional cost to the Owner.
- G. Provide temporary ditching as needed so that no areas of the site will have standing water during rainfall. Fill or pump low areas that cannot otherwise be drained to an acceptable discharge point.

3.02 UTILITIES

- A. Before starting excavation, establish location and extent of underground utilities occurring in work area to the fullest extent possible using locator services.
- B. Maintain existing utility lines to remain which pass through Work area, and as shown on the Drawings.
- C. Protect utility services uncovered by excavation unless noted for removal.
- D. Accurately locate and record abandoned and active utility lines re-routed or extended on Project Record Documents.

3.03 TEMPORARY EROSION AND SILTATION CONTROL

- A. All Work shall conform to Jurisdiction requirements. The Work shall be in accordance with Section 1-07.15 of WSDOT-APWA including APWA supplements except all costs for the Work shall be considered incidental to and included in the bid price.

3.04 PROTECTION OF EXISTING FACILITIES

- A. Pavement: The Contractor shall protect from damage all pavement or paved areas intended to remain.
- B. Access Streets and Roadways: Provide wheel cleaning stations to clean wheel and undercarriage of trucks before leaving site to prevent dirt from being carried onto public streets. If streets are fouled, they must be cleaned immediately in conformance with **[Pierce County]** and all governing requirements and regulations.

- C. Provide protection of existing trees to remain per Section 01 56 39.
- D. Repair and/or replacement of damaged facilities will be accomplished at the Contractor's expense.

**3.05 SITE GRADING**

- A. General: Required contours and elevations are indicated and noted on Drawings; should indicated figures conflict with actual conditions, notify Architect and await his directions before proceeding.

**3.06 EXCAVATION AND GRADING AND FILING**

A. Proofing-Rolling:

- 1. After stripping operations are complete or cuts are complete in any area and prior to fill placement, the area shall be proof-rolled as follows.
  - a. In areas of building and pavement use several passes of heavy rubber tired construction equipment or other equipment as necessary to compact the surface to a dense unyielding condition and to a soil density in the upper 24 in. of exposed granular soil equal to the compaction level noted in paragraph 3.07 of this Section.
  - b. If loose and/or wet spongy zones are detected, the soils should be dried or moistened as required (including scarifying, mixing and/or aeration), reworked, and adequately compacted to the densities previously indicated. Avoid traffic which will introduce pumping of soils and result in softened soils.

B. Excavate and Fill:

- 1. Excavating General: Provide excavation of whatever nature required for construction of the Work; verify character, quality, and disposition of material to be excavated prior to commencing. Blasting will not be permitted.
  - a. Excavate as required to provide grades shown on the Plans.
- 2. Trench Excavation:
  - a. Grade and smooth bottoms of trenches to furnish uniform bearing and support for utility lines; remove rocks and similar material causing point bearings.
  - b. Form bell holes and depressions for joints after grading of bottom limit such depressions to lengths, depths, and widths required for particular type of joint.
  - c. Excavate to depths allowing for bedding.
  - d. Excavate trenches to receive water lines to furnish not less than 36 in. of cover, except where utility or jurisdiction requirements require greater depth or if noted otherwise on the drawings.
- 3. Place structural fill material full cross section width, in layers not exceeding 8 in. loose depth, each layer compacted to dense, unyielding condition as hereinafter specified; depths are required to receive specified work.

4. Machine slope banks are required, and compact to 90%. Maximum slope shall be 2:1 horizontal to vertical.
5. When complete, verify soil bearing capacities, depths, and dimensions.
6. Correct unauthorized excavations directed, at no cost to Owner.
7. Do not disturb soil within branch spread of existing trees that are to remain.
8. If necessary to excavate through roots, perform work by hand and cut roots with a sharp ax.
9. Ensure areas to be backfilled are free from debris, snow, ice and water, and that ground surfaces are not in a frozen condition.
10. Do not backfill over existing sub-grade surfaces which are porous, wet or spongy.
11. Rework and compact existing sub-grade surfaces if densities are not equal to that required for backfill materials.
12. Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.
13. Maintain optimum moisture content of backfill materials to attain required compaction density.
14. Comply with requirements of Section 01 56 39 when excavation or trenching is required within dripline of tree(s) to remain.

C. Wet Weather Conditions:

1. Schedule work in all areas for dry weather periods. If wet weather is encountered and earthwork is unavoidable, Contractor shall at no additional expense to Owner complete the following:
  - a. Slope the ground surface in the construction area to promote the rapid run-off of precipitation and to prevent ponding of water. Pump continuously all areas that pond water during rainfall.
  - b. Accomplish earthwork in small sections to minimize exposure to wet weather by the removal of unsuitable soil and placement and compaction of at least 12 in. of dry structural fill on the same day. Limit the size of equipment to prevent soil disturbance.
  - c. Leave no fill soil uncompacted to soak up water. Use appropriate equipment to daily roll the fill surface to seal out as much water as possible.
  - d. Remove soils that become too wet for compaction and replace with dry on site structural fill material.
  - e. Cover exposed areas with plastic.
  - f. Accomplish excavation and placement of structural fill material in cooperation with the Owner's quality control representative to determine that all work is being accomplished in accordance with these recommendations.



**3.07 COMPACTION**

- A. See proof-rolling specified in 3.06.A, required after stripping topsoil. Compact any site grading and filling performed under this contract with approved compacting devices and materials to attain minimum percentages of modified Proctor maximum dry density, as determined by ASTM D1557 latest edition as follows:
1. Subgrade cut and fill materials for all trenches, paving, walks, building, and cut and fill slopes – 95%. Compact building areas to footprint of building plus height of fill, and paved areas, to 1 foot beyond limits of pavement or to pavement limits plus height of fill, whichever is greater.
  2. Import gravel for buildings and roads – 95%.
  3. Sub-grade and fill materials of all other stripped areas to receive filling – 85%.

**3.08 DISPOSAL OF EARTH MATERIALS**

- A. All excess or unsatisfactory soils material shall be disposed of at a permitted site off the Owner's property selected by the Contractor.
- B. All disposal of waste or excess material shall be at the Contractor's expense and shall meet all federal, state, and local regulations, including requirements of County grading permit.

**3.09 FIELD QUALITY CONTROL**

- A. Contractor is responsible to conduct special inspections to verify conformance with Specifications and Drawings:
- B. Compaction:
1. Compact all fill and backfill to prevent subsequent settlement.
  2. Water settling or jetting will not be permitted as a means of compaction.
  3. Furnish heavy rollers or compactors except as follows:
    - a. Use pneumatic hand tampers for trenches and areas not accessible to heavy equipment.

**3.10 FINISH GRADING**

- A. Finish grade to  $\pm 1\frac{1}{10}$  ft.
- B. Remove all concrete, rocks, rubble and debris larger than 1 in. on a side from surface.
- C. Execute any fine grading as may be necessary or incidental to all future operations.
- D. Finish grades flush with adjacent surfaces unless indicated otherwise.
- E. Finish grades will be inspected and approved by Owner.
- F. Protect and maintain finished surfaces.
1. Allow no heavy objects to move over finish graded surfaces. At no cost to Owner, repair any ruts or holes in finished surfaces, and any obstructions to positive drainage. Repair areas showing settlement.

\*\*\*END OF SECTION\*\*\*

**SECTION 31 25 13  
EROSION CONTROL**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section Includes:

1. Conform to all requirements of National Pollutant Discharge Elimination System (NPDES) Permit and Construction Stormwater Pollution Prevention Plan (CSWPPP), and the Construction Stormwater General Permit.
2. Provide Certified Erosion and Sediment Control Lead (CESCL).
3. Provide and maintain temporary erosion control measures as indicated on the drawings and as required by Washington State Department of Ecology (WSDOE) and the City of Federal Way.
4. Provide and maintain additional temporary erosion control measures, at no additional cost to the Owner, as may become necessary due to weather or environmental conditions.
5. Prevent pollution or excess turbidity in State waters.
6. Removal of temporary erosion control measures after completion of project.

- B. Related Sections:

1. Sections 01 71 23 Field Engineering, 01 73 29 Cutting & Patching, and 01 50 00 Temporary Facilities and Controls GC/CM for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and environmental protection measures during site operations.
2. Division 31 Section 31 20 00 Earth Moving for soil materials, excavating, backfilling, and site grading.

**1.03 REFERENCE STANDARDS**

- A. WSDOT Specification: Standard Specifications for Road, Bridge and Municipal Construction, prepared jointly by the Washington State Department of Transportation, and the American Public Works Association, Washington State Chapter, 2020 edition. All references to measurement and payment shall be deleted from consideration, and terms agreed to in the contract substituted therefore.
- B. Conform to OSHA (Occupational Safety and Health Act) requirements.

- C. Conform to WISHA (Washington State Industrial Safety and Health Act) for trench safety.
- D. Example Construction Stormwater Pollution Prevention Plan (CSWPPP). An example CSWPPP is included at end of this Section.
- E. National Pollution Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Construction Activities by WSDOE: The Owner has applied for this permit as the permit holder. Contractor shall sign Notice of Transfer as required to transfer the permit holder to the Contractor, and submit to WSDOE.

**1.04 DEFINITIONS**

- A. NPDES: National Pollution Discharge Elimination System general permit for stormwater discharges from construction activities.
- B. CSWPPP: Construction Stormwater Pollution Prevention Plan.
- C. CESCL: Certified Erosion and Sediment Control Lead.
- D. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- E. Utilities: On-site and off-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- F. Wet Weather: Between dates of October 1 and April 30. Exposed soil shall not remain uncovered for more than 2 days unless it is being actively worked during this period. No earthwork shall occur during the wet season.
- G. ESC: Erosion and Sediment Control.

**1.05 MATERIALS OWNERSHIP**

- A. Except for materials indicated to be stockpiled or to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from the site.

**1.06 SUBMITTALS**

- A. Submit under provisions of Division 1 Section 01 33 00 Submittals and as further provided.
- B. Submit proof of certification for the CESCL.
- C. Submit copies of CESCL field reports, ESC Maintenance Reports, and stormwater sampling reports to WSDOE, Owner, and Architect within 24 hours of each inspection, and as required by NPDES General Permit for Stormwater Discharges from Construction Activities.
- D. Certification
  - 1. Provide a letter, signed by the supplier and reviewed and also signed by an officer of the General Contractor's company, certifying that the following products to be incorporated into the work meet the requirements specified.

2. Products:
  - a. Filter Fabric Fence
  - b. Plastic Sheeting
  - c. Mulch
  - d. Hydroseeding Mix
  - e. Catch Basin Inlet Protection
  - f. Erosion Control Blanket
- E. Submit confirmation from the WSDOE confirming contractor is the permit holder of the NPDES General Permit for Stormwater Discharges from Construction Activities.
- F. Submit confirmation from the WSDOE confirming NPDES General Permit for Stormwater Discharges from Construction Activities is terminated at project completion.
- G. Construction Stormwater Pollution Prevention Plan (CSWPPP): Contractor shall provide a site specific CSWPPP. An example CSWPPP is provided at the end of this Section. Contractor's CSWPPP shall meet the minimum requirements of the NPDES Permit and the King County Surface Water Design Manual, as adapted by City of Federal Way Storm Manual requirements.

#### 1.07 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. The Contractor shall utilize a utility locate service and shall notify affected utility companies before starting work and comply with all their requirements. The Contractor shall conform to applicable regulatory procedures when discovering hazardous or contaminated materials.
- C. The locations of existing underground utilities are approximate only and have not been independently verified by the Owner or its representative. The Contractor shall determine the exact location of all existing utilities before commencing work and shall be fully responsible for any and all damages that happen due to the Contractor's failure to locate exactly and preserve all underground utilities that are designated to remain.
- D. The contractor shall include in his bid the maintenance and addition of erosion control measures as needed to comply with City of Federal Way and WSDOE requirements.

#### 1.08 QUALITY ASSURANCE

- A. Maintain a copy of the NPDES permit and CSWPPP on the project site.
- B. Maintain at least one copy of the WSDOT Standard Specifications for Road, Bridge and Municipal Construction, latest edition, and project plans and specifications on-site.

- C. Field inspection and testing will be performed under Section 01 45 23 Testing and Inspecting Services.
- D. Tests and analysis of aggregate material will be performed in accordance with ANSI/ASTM D1557, ASTM D2922, ASTM D3017, ASTM D4318, and ASTM C136, as applicable.
- E. If tests indicate materials do not meet specified requirements, change material and retest or obtain written approval of the Engineer. Costs associated with the retesting of materials will be the responsibility of the Contractor.
- F. Construction Conference: Conduct conference at Project site to comply with requirements in Division 1 Section 01 45 00 Quality Control.

#### 1.09 REGULATORY REQUIREMENTS

- A. Conform to all requirements of the NPDES under WSDOE's General Permit for Stormwater Discharges from Construction Activities and the CSWPPP. Contractor and their CESCL shall be responsible for maintaining all required records in regard to the following:
  - 1. Construction activities.
  - 2. Inspections.
  - 3. Stabilization measures.
  - 4. Maintenance.
  - 5. Stormwater discharges and sampling for turbidity and pH.
  - 6. Contractor is responsible for complying with permit, and is responsible for reporting and fees/penalties associated with non-compliance.
- B. Conform to applicable agency code for dust control and runoff control.
- C. Obtain, post, and pay for required permits from authorities according to provisions of the Contract, including General and Supplemental Conditions and Division 01 Specification Sections.
- D. Proposed erosion control facilities are minimum requirements for anticipated site conditions. During the construction period, the erosion control facilities shall be maintained and/or modified as needed to comply with City of Federal Way erosion control policies, the NPDES, and as directed by Owner.

#### 1.10 COORDINATION

- A. Coordinate work under provisions of Division 1 Section 01 45 00 Quality Control.
- B. Erosion control measures shall be maintained, coordinated, adjusted, and added to address changes in site conditions and construction phases at no additional cost to the Owner.

1.11 INTENT

- A. It is the intent of this Specification that the Contractor provide the Work defined herein complete in every respect, and in accordance with the good practices involved in the installation of erosion control facilities, including modifying facilities as needed for storm events and changing site conditions, and the requirements of this Specification, regardless of whether or not full details of such completeness, workmanship, or practices are contained herein.

PART 2 - PRODUCTS

2.01 EROSION AND SEDIMENT CONTROL MATERIALS

- A. Filter Fabric Fence: Conform to detail. Geotextile fabric shall meet the following standards:

Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film wovens (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve).
Water Permittivity (ASTM D4491)	0.02 sec <sup>-1</sup> minimum
Grab Tensile Strength (ASTM D4632)	100 lbs minimum for standard strength fabric.
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- B. Construction Entrances and Roads: Conform to detail on plans. Provide 12-inch thick construction accesses and entrances, per the plans, to allow access.
- C. Quarry Spalls: Conform to WSDOT 9-13.6.
- D. Plastic Sheeting: Conform to WSDOT 9-14.5(3).
- E. Hydroseeding: Conform to notes on plan.
- F. Straw Mulch: Conform to notes on plan. Air dried hay or straw; free from undesirable seed and coarse material, 2-inch depth minimum with no bare spots.
- G. Rock Check Dam: Conform to WSDOT 9-14.5(4).
- H. Catch Basin Inlet Protection: Conform to detail on plans.
- I. Erosion Control Blanket: Conform to WSDOT 9-14.5(2). Place erosion control blanket on all disturbed areas with slopes steeper than 3H:1V in accordance with WSDOT Standard Plan I-60.10-01. Hydroseed after placement of erosion control blanket.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that site conditions are satisfactory to receive the work of this Section. Do not begin the work of this Section until unsatisfactory conditions are corrected. Beginning the work of this Section constitutes the Contractor's acceptance of site conditions as satisfactory.

- B. CESCL shall be responsible for ESC measures. The CESCL shall be designated prior to commencement of work on-site.

### 3.02 INSTALLATION AND CONDUCT OF WORK

- A. Complete and receive approval of the site specific CSWPPP.
- B. Install temporary erosion control measures as indicated on the Drawings, or as directed by the Owner's Representative or the City of Federal Way Inspector prior to beginning any work that will disturb the existing vegetation on the site.
- C. Install erosion control measures to minimize impacts to the existing site conditions and to allow proper performance.
- D. Conduct all work in order to prevent water pollution as set forth in the APWA Supplement to Section 1-07.15 of WSDOT-APWA.
- E. Straw mulch shall be applied with a 2-inch minimum thickness with no bare spots.
- F. Erosion and sediment control measures shall be in place and functional as identified in the Contract Documents and as necessary to prevent stormwater pollution at all times.
- G. Provide and maintain additional temporary erosion control measures at no additional cost to the Owner as necessary due to weather or environmental conditions and to comply with governing agency and permitting requirements.
- H. Prevent pollution or excess turbidity in State waters as identified in the CSWPPP and NPDES permits.
- I. Contractor shall, prior to any work being performed on the site, post a weatherproof sign at the site perimeter that provides the CESCL name, phone and fax numbers, and address information. Sign and text must be of sufficient size that the information can be easily read from a distance of 10 feet, as determined by the Architect. Sign placement location shall be approved by the Architect.
- J. Contractor shall conform to requirements of the National Pollution Discharge Elimination System (NPDES) Permit, the Construction Stormwater General Permit, and the site specific Construction Stormwater Pollution Prevention Plan (CSWPPP).
- K. The Owner is applying for the NPDES Permit and the Contractor shall apply for and accept transfer of the Permit coverage from the Owner prior to start of work. An example site specific CSWPPP is attached to this section.

### 3.03 MAINTENANCE AND INSPECTION

- A. Temporary erosion control measures shall be maintained as required to achieve proper performance, as indicated in the Contract Documents and required by the Owner's Representative, permit agency, and as required by WSDOE.
- B. Use care during maintenance of erosion control facilities so as not to discharge collected sediment into the protected area.



- C. The Contractor shall provide and designate a Certified Erosion and Sedimentation Control Lead (CESCL) who shall be responsible for monitoring the installation, performance, maintenance, and review of ESC measures, and for compliance with all permit conditions. The CESCL shall be designated prior to commencement of work on the site.
1. CESCL shall have completed the training and certification requirements of BMP C160 of the WSDOE Stormwater Management Manual for Western Washington.
  2. CESCL shall maintain a site logbook.
  3. CESCL shall inspect erosion control measures at least once every calendar week and within 24 hours of any discharge from the site. Inspections shall commence when clearing work begins and continue until site work is substantially complete and permitting jurisdiction has accepted project as complete.
- D. CESCL shall conduct turbidity sampling as required by WSDOE General Permit for Stormwater Discharges from Construction Activity.
- E. Contractor shall provide a contact phone number, fax number, and address where the CESCL can be contacted. The CESCL shall have completed the training and certification requirements of BMP C160 of the WSDOE Stormwater Management Manual for Western Washington.
1. CESCL responsibilities include:
    - a. Be on-site or available on-call during the project duration.
    - b. Implement the TESC and the CSWPPP.
    - c. Oversee maintenance practices identified on the plans for the erosion control measures.
    - d. Conduct or provide for inspection and monitoring activities.
    - e. Identify other potential pollution sources and make sure they are mitigated.
    - f. Identify deficiencies in the TESC measures and make sure they are corrected.
  2. Contractor shall, prior to any work being performed on the site, post a weatherproof sign at the site perimeter that provides the CESCL name, phone and fax numbers, and address information. Sign and text must be of sufficient size that the information can be easily read from a distance of 10 feet, as determined by the Architect. Sign placement location shall be approved by the Architect.
  3. Contractor shall conform to requirements of the NPDES Permit and the Construction Stormwater General Permit, and the site specific CSWPPP. The Owner is applying for the NPDES Permit, and the Contractor shall accept transfer coverage of the Permit coverage from the Owner and shall provide a site specific CSWPPP prior to the start of work. The Construction Stormwater General Permit is to be considered part of these Specifications. An example CSWPPP is attached to this Specification section.

### 3.04 REMOVAL

- A. When approved by the City of Federal Way Inspector and WSDOE, remove temporary facilities when the need for the facilities no longer exists.
- B. Clean sediment and/or pollutants from facilities that are to remain.

**3.05 CLEAN-UP**

- A. Upon completion of the work of this Section, remove all rubbish, trash, and debris resulting from operations.
- B. Remove materials, equipment, and tools; leave the site in a neat and orderly condition acceptable to the Owner's Representative.
- C. At the completion of the site improvements and after the work area has been stabilized with final surfacing and landscaping or seeding, the contractor shall remove all temporary erosion control mechanisms and facilities.
- D. The contractor shall sweep streets as necessary to remove sediment from the project, and at project completion.

**3.06 WASTE MANAGEMENT**

- A. See Division 01 Section 01 50 00 Temporary Facilities and Controls GC/CM and the requirements of Part 1 of this section for requirements related to waste management.

**3.07 PERMIT TERMINATION**

- A. The contractor is responsible for completing and submitting the "Notice of Termination Form" to close the NPDES Construction Stormwater General Permit. Provide copies of Notice of Termination to Owner and Architect and documentation that permit has been terminated.

\*\*\*END OF SECTION\*\*\*

# SECTION 31 25 13 ATTACHMENT

## Example Construction SWPPP (to be provided at a later date)

**SECTION 32 05 33  
LANDSCAPE ESTABLISHMENT**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes the requirements for care of seed areas, plant material, soils, and irrigation for all areas during the Plant Warranty and Plant Establishment Period per the Plant Establishment Plan.
- B. Related Requirements:
  - 1. Section 01 00 00 – General Requirements
  - 2. Section 31 22 00 – Earthwork
  - 3. Section 32 84 00 – Irrigation
  - 4. Section 32 93 13 – Soil Preparation
  - 5. Section 32 92 00 – Turf and Grasses
  - 6. Section 32 93 00 – Plants

**1.02 DEFINITIONS**

- A. See Section 32 93 00 – Plants.

**1.03 SUBMITTALS**

- A. Reporting on Plant Establishment Services
  - 1. Submit monthly reports of activities per the Plant Establishment Plan and Plant Establishment Services in Part 3.
  - 2. Each Monthly report requires the signature of the Owner as detailed in Part 3.
- B. Closeout Submittals
  - 1. Tree Staking and Guying Removal Report, including date of completion.
  - 2. Mulch Replenishment Report, including receipt for top mulch, application rate to areas, and date of completion.

**1.04 QUALITY ASSURANCE**

- A. Qualifications: A qualified landscape Installer whose work has resulted in the successful establishment of plants.
  - 1. Professional Membership: The Installer shall be a member in good standing of the American Nursery and Landscape Association or approved equal.

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2. Experience: Five years' experience in landscape installation, planting, and irrigation care in addition to requirements in Division 01 Section "Quality Requirements."
3. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
  - a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
  - b. Certified Landscape Technician.
  - c. Certified Ornamental Landscape Professional, designated COLP.
  - d. Certified IPM Technician.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
- B. Bulk Materials:
  1. Do not dump or store bulk materials near structures, utilities, walkways, pavements, or existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

**1.06 PLANT ESTABLISHMENT PLAN**

- A. During the Plant Establishment period, the Contractor shall be responsible for performing all work necessary to ensure the resumption and continued growth of the plant material. This care shall include, but not be limited to:
  1. Labor and materials necessary for removing foreign, dead, or rejected plant material and maintaining a weed-free condition.
  2. The replacement of all unsatisfactory plant material planted under the Contract.
- B. Coordinate with the irrigation contractor to adjust the schedule to achieve healthy growth of plants. It is the responsibility of the Plant Establishment Contractor to communicate issues with the irrigation schedule or performance directly to the irrigation contractor. If the performance of the Irrigation system is not satisfactory, notify the Owner's Representative in writing.

**1.07 PLANT ESTABLISHMENT SERVICE**

- A. Provide Plant Establishment services for all plant and irrigation materials by skilled employees of the landscape Installer. Provide services as required in Part 3. Begin Plant Establishment services immediately upon approval of Completion of Planting and Irrigation and continue through the Plant Establishment period, as defined below:
  1. Plant Establishment Period: One (1) years from the date of approved Completion of Planting and Irrigation

2. Per the Plant Establishment Services Schedule, provide hand watering, gator bags, or other temporary irrigation systems to plants not served by irrigation systems on an as-needed basis.
- B. During the Plant Establishment period, it shall be the Contractor's responsibility to perform all work necessary to ensure the resumption and continued growth of the plant material. This care shall include, but not be limited to:
1. Labor and materials necessary for removal of foreign, dead, or rejected plant material, and maintaining a weed-free condition.
  2. The replacement of all unsatisfactory plant material planted under the Contract.
- C. All automatic irrigation systems shall be operated fully automatically during the Plant Establishment period and until final acceptance of the Contract.

#### 1.08 WARRANTY

- A. Warranty: Installer agrees to repair or immediately replace plantings and accessories that fail in materials, workmanship, or growth within the specified warranty period.
1. The Warranty Period for plant material shall be one (1) years from the date of approved Completion of Planting.
  2. Failures include, but are not limited to, the following:
    - a. Death and unsatisfactory growth, except for defects resulting from abuse or incidents that are beyond Contractor's control.
    - b. Structural failures, including plantings falling or blowing over.
  3. Include the following remedial actions as a minimum:
    - a. Immediately replace plants that are in an unhealthy condition, as determined by the Architect, Landscape Architect or SPS Maintenance Staff, excepting plants with specific seasonal planting requirements.
      - 1) A tree shall be considered dying or dead when the main leader has died back, or a minimum of 25 percent of the crown has died. A shrub or groundcover shall be considered dying or dead when a minimum of 25 percent of the plant has died. This condition may be determined by visual inspection and scraping a 1/16-inch square area of a branch, maximum, to determine if material is green and alive or brown and dead or dying.

#### 1.09 BONDS

- A. All of the work of this section is to be under an establishment period bond to be paid out incrementally upon completion of monthly services. Services will not be considered complete without the monthly reports signed and approved by the Owner.

PART 2 - PRODUCTS

- A. See Section 32 92 00 - Turf and Grasses Part 2.
- B. See Section 32 93 00 - Plants Part 2.

PART 3 - EXECUTION

3.01 GENERAL

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, and viable plantings. Coordinate with the Irrigation contractor to maintain appropriate watering for new plants to thrive.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply certified Organic treatments, as required, to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use the Owner's integrated pest management (IPM) practices to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.02 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Do not apply pruning paint to wounds.
- C. Discard all trimmings off-site using a legal method.
- D. The cutting blades on pruning shears, clippers, blades, saws, etc. shall be sterilized after pruning each tree and every 3 shrubs to minimize the possibility of spreading disease. When pruning trees known or suspected to be diseased, cutting blades shall be sterilized after each cut. Sterilize blades by dipping them in a solution of 1 part bleach and 9 parts water or heavily spray them with a disinfectant spray, such as Lysol. After dipping or spraying, wait 20 seconds before using again.
  - 1. Prune trees only in appropriate months as specified herein or as determined by an Arborist. Prune in accordance with generally accepted standards for proper pruning.
  - 2. Meet jurisdictional vertical clearance restrictions for street trees and trees above all parking spaces. Trim trees to remove all limbs within these areas.

3.03 PLANTING AREA MULCHING

- A. At the end of the Landscape Establishment period, apply 1" of Top Mulch to all surfaces of planting areas and other areas indicated.
  - 1. Trees and Tree-like Shrubs in Turf Areas: Apply Top Mulch to maintain a ring of 3-inch average thickness, with 36-inch radius around trunks or stems or as indicated on plans. Do not place top mulch within 3 inches of trunks or stems.

2. Planting Areas: Apply Top Mulch to maintain a total depth of top mulch of 3 inches in tree and shrub areas and 2 inches in groundcover areas only where groundcover has not completely covered areas.
3. In all instances, feather back Top Mulch from stems or trunks of plants per Contract Documents.

**3.04 WEED AND PEST CONTROL PLAN**

- A. See Section 32 93 00 - Plants.

**3.05 PESTICIDE APPLICATION**

- A. See Section 32 93 00 - Plants.

**3.06 PLANT ESTABLISHMENT REQUIREMENTS**

- A. General:

1. Provide a written record to the Owner's Representative at the end of each month during the Plant Establishment period of each task completed that month.
2. The signature of the Owner's representative confirming acceptance of satisfactory completion of each month's task, especially the elimination of weeds, is required.
3. At the end of the plant establishment period, apply a layer of finely shredded bark mulch in planting areas to achieve the thickness stated above under Mulching.
4. 'Shrub beds' includes tree, shrub, and groundcover planting areas.
  - a. Excludes sports fields, unimproved buffer areas, and unimproved tree protection areas.
5. Frequency is twice a month unless otherwise noted.

- B. Plant Establishment Services Schedule

1. The following monthly service schedule is provided as a basis of anticipated maintenance efforts for exterior planting and irrigation. Review requirements stated herein and per related Specification Sections for additional information. The Landscape Establishment contractor shall not adjust irrigation systems unless they are one and the same as the irrigation contractor as per Section 32 84 00 - Irrigation. Otherwise, the Landscape Establishment contractor shall coordinate with the Irrigation contractor to adjust and or fix irrigation systems as required and described below:
2. Monthly Schedule
  - a. January:
    - 1) Prune any tree branches that interfere with public safety.
    - 2) Remove any debris that has fallen on site, including, but not limited to, branches cones and leaves.
    - 3) Smart Weeding: Springtime "Smart Weeding" is a deep weeding, roots included. Sub-sequent weeding throughout the growing season can be limited to surface hoeing if weeds have germinated in the 2



weeks prior to weeding and are not more than 2" tall or long and have not gone to seed.

- b. February:
  - 1) Remove any debris that has fallen on site, including, but not limited to, branches cones and leaves.
  - 2) Smart Weeding: Remove 100% of all weeds from shrub beds. (bi-weekly)
- c. March:
  - 1) Inspect grounds and remove debris. (bi-weekly)
  - 2) Smart Weeding: Remove 100% of all weeds from shrub beds. (bi-weekly)
  - 3) Soil test (Twice yearly—see October): Send soil samples to a soil testing laboratory to determine supplemental fertilizer or other amendments needed. Provide amendments at rates prescribed by the soil testing laboratory for each plant type. Submit receipts to the authorized Owner's Representative as proof of soil testing.
  - 4) Fertilize trees, shrubs, and groundcovers only as required by soil test. Make the application prior to a moderate rainfall in drip-irrigated zones so the rain will wash the fertilizer into the soil. Apply Dolomite as required if soil registers as acidic. Submit receipts to the authorized Owner's Representative as proof of fertilizer and amendments purchased.
  - 5) Mow all seeded areas.
- d. April:
  - 1) Inspect grounds and remove debris. (bi-weekly)
  - 2) Smart Weeding: Remove 100% of all weeds from shrub beds. (bi-weekly)
  - 3) Coordinate with Irrigation Contractor to ensure that the irrigation system has been activated. (April 1) Activation includes, but is not limited to the following:
    - a) Flush out irrigation systems as needed and check for proper operation of each valve zone.
    - b) Remove and clean wye filter screens.
    - c) Clean or replace plugged sprinkler nozzles. Replace plugged drip emitters.
    - d) Replace irrigation controller program back-up batteries.
  - 4) Coordinate with Irrigation Contractor to adjust irrigation watering schedule to maintain thriving plants.
  - 5) Mow all seeded areas.
- e. May:
  - 1) Inspect grounds and remove debris. (bi-weekly)
  - 2) Smart Weeding: Remove 100% of all weeds from shrub beds. (bi-weekly)

- 3) Coordinate with Irrigation Contractor to adjust irrigation watering schedule to maintain thriving plants.
  - 4) Mow all seeded areas.
- f. June:
- 1) Inspect grounds and remove debris. (bi-weekly)
  - 2) Water as necessary to maintain thriving plants.
  - 3) Smart Weeding: Remove 100% of all weeds from shrub beds. (bi-weekly)
  - 4) Coordinate with Irrigation Contractor to adjust irrigation watering schedule to maintain thriving plants.
  - 5) Mow all seeded areas.
- g. July:
- 1) Inspect grounds and remove debris. (bi-weekly)
  - 2) Smart Weeding: Remove 100% of all weeds from shrub beds. (bi-weekly)
  - 3) Coordinate with Irrigation Contractor to adjust irrigation watering schedule to maintain thriving plants.
  - 4) Mow all seeded areas.
- h. August:
- 1) Inspect grounds and remove debris. (bi-weekly)
  - 2) Smart Weeding: Remove 100% of all weeds from shrub beds. (bi-weekly)
  - 3) Coordinate with Irrigation Contractor to adjust irrigation watering schedule to maintain thriving plants.
  - 4) Mow all seeded areas.
- i. September:
- 1) Inspect grounds and remove debris. (monthly)
  - 2) Smart Weeding: Remove 100% of all weeds from shrub beds. (bi-weekly)
  - 3) Coordinate with Irrigation Contractor to adjust irrigation watering schedule to maintain thriving plants. (biweekly)
  - 4) Mow all seeded areas.
- j. October:
- 1) Inspect grounds and remove debris. (monthly)
  - 2) Soil test: Send soil samples to a soil testing laboratory to determine supplemental fertilizer or other amendments needed. Provide amendments at rates prescribed by the soil testing laboratory for each plant type. Submit receipts to the authorized Owner's Representative as proof of soil testing.

- 3) Fertilize trees, shrubs, and groundcovers only as required by soil test. Make the application prior to a moderate rainfall in drip-irrigated zones so the rain will wash the fertilizer into the soil. Apply Dolomite as required if soil registers as acidic. Submit receipts to the authorized Owner's Representative as proof of fertilizer and amendments purchased.
  - 4) Drain manual drains at low points (15 October).
  - 5) Smart Weeding: Remove 100% of all weeds from shrub beds. (monthly)
  - 6) Coordinate with the Irrigation Contractor to adjust the irrigation watering schedule to maintain thriving plants.
  - 7) Coordinate with Irrigation Contractor to prepare irrigation system for winter. Make sure backflow preventer is well insulated or drained prior to the first freeze. Blow out pipes using compressed air in areas where freezing could result in breakage.
  - 8) Mow all seeded areas.
- k. November:
- 1) Inspect grounds and remove debris. (monthly)
  - 2) Smart Weeding: Remove 100% of all weeds from shrub beds. (monthly)
- l. December:
- 1) Inspect grounds and remove debris (monthly).

### 3.07 LANDSCAPE ESTABLISHMENT CARE OF PLANTED AREAS

#### A. Trees:

1. Trees shall be maintained in a healthy, vigorous growing condition, free from disease and large concentrations of pests.
2. Any tree found to be dead or missing shall be replaced with plant material of identical species at the Contractor's expense. Replacement trees shall be equal in size to the originally installed tree at the time it died and shall be planted per the Contract Document planting details.
3. At the end of the Landscape Establishment period, remove stakes from site and recycle or dispose by a legal method.

#### B. Shrubs and Vines:

1. Shrubs and vines shall be kept in a healthy, vigorous condition, free from disease and large concentrations of pests.
2. Any shrub found to be dead or missing shall be replaced with plant material of identical species found in the Contract Documents at the Contractor's expense. The replacement plant shall be equivalent to the size of other plants of the same variety that are on site.

- C. Groundcover:
  - 1. Groundcover shall be maintained in a healthy, vigorous growing condition.
  - 2. Any groundcover found to be dead or missing shall be replaced with plant material of identical species at the Contractor's expense. The replacement plant shall be equivalent to the size of other plants of the same variety that are on site.
- D. Fertilizer Use:
  - 1. Only fertilize as indicated in Section 32 92 00 and 32 93 00 and by agricultural suitability soil test.
- E. Weed Control:
  - 1. Weeds in planted areas, sidewalks, curbs, gutters, or pavement shall be removed or killed completely. Weeds shall be removed (not just killed) if they are larger than 2 inches (5 cm) in height or diameter. Dispose of weeds off-site. Pre- and post-emergent herbicides may be used ONLY if approved in the Weed and Pest Control Plan, as noted in section 32 93 00 - Plants. For example, hoeing or raking early in the germination of weeds (when the first tender shoots are present) can eliminate the need for 100% removal of the weed growth.
  - 2. Smart Weeding:
    - a. 100% removal of weeds early in the growing season, and relative to weed seed lifecycles, especially prior to seed production is the objective in order to limit future weed-removal efforts. Providing more intense weeding early in the growing season and tied to weed seed germination can be used to eliminate the frequency of visits during the remainder of growing seasons, if approved by the Owner, and demonstrated by lack of weed growth.
- F. Chemicals, Herbicides, Pesticides
  - 1. Follow Seattle Public Schools IPM standards regardless of project location or type.

### 3.08 DISPOSAL

- A. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off the Owner's property.

### 3.09 WARRANTY WALKTHROUGH

- A. Contractor to walk the site with staff quarterly to check the status of the site. The walk shall include the Contractor, Project Manager and Maintenance Staff. The project Landscape Architect shall be in attendance at least 1 time per year. The Contractor shall set up these meetings at the end of the project construction period.
- B. Contractor to walk the site with the maintenance staff at the end of the establishment period. During this walk, the Contractor shall provide a complete record of all work completed during the Plant Establishment period, per Part 3 of this section 'Plant Establishment Requirements'. The Contractor shall walk the maintenance staff through all areas, noting any areas that have specific or irregular needs, in order to pass this knowledge on.

3.10 **CLEAN UP AND LITTER REMOVAL**

- A. Do not sweep or blow trash, leaves, clippings, or landscape debris into planters or onto adjacent property. Collect all debris swept or blown from landscape areas and remove from the site.

\*\*\*END OF SECTION\*\*\*

**SECTION 32 13 13  
EXTERIOR CONCRETE PAVING**

**PART 1 - GENERAL**

**1.01 REFERENCES**

- A. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- B. ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.
- C. ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
- D. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
- E. ASTM C33 - Concrete Aggregates.
- F. ASTM C94 - Ready Mix Concrete.
- G. ASTM C150 - Portland Cement
- H. ASTM C260 - Air-Entraining Admixtures for Concrete.
- I. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- J. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
- K. WSDOT-APWA - Standard Specifications for Road, Bridge and Municipal Construction (Latest Version).

**1.02 QUALITY ASSURANCE**

- A. Perform work in accordance with ACI 301.
- B. Obtain cementitious materials from same source throughout.

**1.03 ENVIRONMENTAL REQUIREMENTS**

- A. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

**1.04 ALTERNATES**

- A. See Section 01 23 00 for bidding alternates affecting the work of this Section.

**1.05 COLORS**

- A. Colors are specified on Colors and Materials Schedule on drawings.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

- A. Formwork: Matched, tight fitting and adequately stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of concrete.
- B. Joint Filler and Sealant: Shall be in accordance with WSDOT Section 9-04.1 and 9-04.2.

2.02 REINFORCEMENT

- A. Reinforcing Steel: Refer to Structural General Notes on Structural Drawings.
- B. Welded Steel Wire Fabric: Refer to Structural General Notes on Structural Drawings.
- C. Tie Wire: Annealed steel, minimum 16 gauge size.

2.03 CRUSHED GRAVEL BASE COURSE

- A. Provide a crushed rock base course of 1-1/4 inch maximum crushed aggregate described as follows:

- 1. Gravel base shall consist of granular material, either naturally occurring or processed. It shall be essentially free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact readily and shall meet the following test requirements:

Stabilometer "R" Value	72 min.
Swell pressure	0.3 psi max.

- 2. The maximum particle size shall not exceed 2/3 of the depth of the layer being placed.
- 3. Gravel base shall meet the following requirements for grading and quality.

<u>Sieve Size</u>	<u>Percent Passing</u>
square	25 min.
No. 200	10.0 max.
Dust Ratio:    % Passing U.S. No. 200	2/3 max.
% Passing U.S. No. 40	
Sand Equivalent	30 min.

All percentages are by weight.

- 4. Gravel base material retained on a 1/4-inch square sieve shall contain not more than 0.20 percent by weight of wood waste.

2.04 CONCRETE MATERIALS

- A. Concrete Pavement and Curbs: Refer to structural notes for concrete.

2.05 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1.
- B. Clear Sealer: L&M Construction Chemicals, LATICRETE International Inc.: "Aquapel Plus".

- C. Surface Retarder.
- D. Joint Filler: ASTM D994; asphalt impregnated fiberboard or felt, 1/4 inch thick; full depth of concrete slab.

**2.06 ADMIXTURES**

- A. Use accelerating admixtures in cold weather only when acceptable to Architect. Use of admixtures shall not relax cold weather placement requirements. Do not use calcium chloride.
- B. Use set-retarding admixtures during hot weather only when acceptable to Architect.
- C. Air entrainment, ASTM C260 at all exterior concrete.

**2.07 CONCRETE MIX**

- A. Mix concrete in accordance with ASTM C94. Refer to Civil Notes.

**2.08 TACTILE WARNING SURFACE**

- A. Engineered Plastics, Inc. (800) 682-2525. Armor-Tile detectable tactile warning tile. Truncated dome pattern and slip resistance shall meet the requirements of the Americans with Disabilities Act and applicable codes. Tiles shall have embedment flanges and shall be set in place during concrete installation. Provide size indicated. Color: Safety yellow.

**PART 3 - EXECUTION**

**3.01 EXAMINATION**

- A. Verify compacted granular base is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Beginning of installation means acceptance of existing conditions.

**3.02 PREPARATION**

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Notify Architect/Engineer minimum twenty-four (24) hours prior to commencement of concreting operations.

**3.03 FORMING**

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

**3.04 REINFORCEMENT**



- A. Place reinforcement at mid-height of slabs-on-grade.
- B. Interrupt reinforcement at control joints.
- C. Place reinforcement to achieve pavement and curb alignment as detailed.
- D. Provide doweled joints at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement.

3.05 **PLACING CONCRETE**

- A. Place concrete in accordance with ACI 304.
- B. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
- C. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.06 **JOINTS**

- A. Place control joints at maximum 20-ft intervals. Align curb, gutter, and sidewalk joints.
- B. Place joint filler between paving components and building or other appurtenances.
- C. Extend joint fillers full width and depth of joint (less sealant thickness), not less than 1/2 inch or more than 1 inch below finished surface where joint sealer is indicated.
- D. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
- E. Protect top edge of joint filler during concrete placement with a metal cap or other temporary materials. Remove protection after concrete has been placed on both sides of joint.
- F. Tool dummy joints at maximum 5-ft intervals.

3.07 **EXPOSED AGGREGATE**

- A. Wash exposed aggregate surface with acid etch solution exposing aggregate to match sample panel.

3.08 **FINISHING**

- A. Exterior Concrete Paving: **[Light broom.] [Wood float.] [Exposed aggregate.]**
- B. Place **[curing compound and]** clear sealer on exterior concrete paving surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.09 **TACTILE WARNING TILES**

- A. Place and finish concrete to required levels prior to installation of tile. Install tactile warning tiles directly in freshly placed concrete by tamping or vibrating into place in accordance with manufacturer's detailed installation instructions. Tile shall not be placed by stepping on the tile to embed. Field level of the tile shall be flush with adjacent concrete surface. Finish adjacent concrete edges around the tile with a 3/8 inch radius edging tool. Place weights on the tile as recommended by the manufacturer to prevent floating or loss of contact between tile and concrete during concrete curing. Remove protective plastic after concrete has

substantially cured.

3.10 **PROTECTION**

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury. Do not allow traffic or external forces in contact with tactile warning tiles during concrete curing stage, to avoid dislodging tiles or creating voids beneath the tiles.

\*\*\*END OF SECTION\*\*\*

**SECTION 32 31 10  
METAL SECURITY FENCES AND GATES**

**PART 1 - GENERAL**

**1.01 REFERENCES**

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
- C. ASTM B221 - Aluminum and Aluminum Alloy Extruded Bars, Shapes and Tubes
- D. ASTM D523 - Test Method for Specular Gloss.
- E. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
- F. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
- G. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- H. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
- I. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- J. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
- K. ASTM F2408 - Ornamental Fences Employing Galvanized Steel Tubular Pickets.
- L. IFC - International Fire Code, Section 503, Fire Apparatus Access Roads.

**1.02 SUBMITTALS**

- A. Section 01 33 00 - Submittals: Procedures for submittals.
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.
- D. Mock up: 12X30 samples of fencing & topper.

**1.03 QUALITY ASSURANCE**

- A. Perform Work in accordance with manufacturer's instructions.

1.04 **QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three (5) years documented experience.

1.05 **PRODUCT WARRANTY**

- A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 15 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering, or corroding.

1.06 **ALTERNATES**

- A. See Section 01 23 00 for bidding alternates affecting the work of this Section.

1.07 **COLORS**

- A. Colors are specified on Colors and Materials Schedule on drawings.

PART 2 - PRODUCTS

2.01 **MANUFACTURER**

- A. Fencing and Gate systems, Steel security fence and gate system Basis of Design: Ameristar Impasse II Anti-Scale Trident, 3-Rail fence style System manufactured by Ameristar Fence Products, Inc., in Tulsa, Oklahoma; or approved.
- B. Pedestrian Entrance Gates. Steel gate system Basis of Design: Ameristar Exodus Egress Gate, Flange Mounted, anti-scale pale with perforated metal infill, manufactured by Ameristar Perimeter Security., in Tulsa, Oklahoma; or approved.
- C. Cantilevering and Swing Traffic Gates: Steel high security fence and gate system Basis of Design: Ameristar TransPort IS Anti-Scale Trident Cantilever Gate System manufactured by Ameristar Fence Products, Inc., in Tulsa, Oklahoma; or approved.

2.02 **MATERIAL**

- A. FENCING & PEDISTRIAN SERVICE GATES
1. Contractor to provide (4) four Service gates, location by owner. Each with padlock hardware
  2. Steel material for fence framework (i.e., corrugated pales, rails and posts), when galvanized prior to forming, shall conform to the requirements of ASTM A924/A924M, with a minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft<sup>2</sup> (276 g/m<sup>2</sup>), Coating Designation G-90.
  3. Material for corrugated pales shall be a nominal 2.75" x .75" x 14 Ga. The cross-sectional shape of the rails shall conform to the manufacturer's Impasse II® rail design a nominal 2" x 2" x 11 Ga. Pre-drilled holes in the Impasse II® rail shall be spaced 4-3/16" on center, providing a pale airspace of no greater than 1-1/2" (38mm). Tamperproof fasteners shall be used to fasten each pale to rail at every intersection. Posts shall conform to the manufacturer's I-Beam design with a nominal 3" x 2.75" x 12 Ga. for fence panel heights up

to & including 8' height

4. Concrete: Type specified in Section 03 30 00.

**B. PEDISTRIAN ENTRANCE GATES**

1. Contractor to provide (2) two Pedestrian Entrance gates, at locations shown on drawings at entry points from city sidewalk.
2. Steel material for gate framework (i.e., jamb frame & gate), shall be galvanized prior to forming in accordance with the requirements of ASTM A653/A653M, with minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft<sup>2</sup> (276 g/m<sup>2</sup>), Coating Designation G-90.
3. Infill frame shall be 12ga steel. Perforated metal mesh shall be Wireworks Anti-climb.
4. Pales shall be 2.75" x .75" x 14ga. corrugated shape. Standard pale spacing shall anti-scale pale spacing 3.25" o.c.
5. Head Kit, to match adjacent fence system.
6. Gate shall be 1.75" x 14ga steel reinforced structural design with ¼" plate reinforced hinge mounting.
7. Hinges shall be stainless steel five knuckle bearing hinges with non-removable pin and stainless-steel fasteners.
8. Pedestrian gate opener shall comply with ANSI A156.19 and UL325 standards. Gate operator shall be outdoor rated, continuous duty, and manufacturer tested to 75,000 cycles without fail. Operator shall be pre-installed to gate and gate frame by manufacturer. Gate to have caution sign mounted with exterior rated adhesive, sign shall be 0.040" thick aluminum. Signage and placement to be compliant with ANSI A156.19 standards. Gate shall have integrated terminal box for site specific low voltage connections including power and non-powered door access switch push button options. Internal wiring shall be UL compliant and weather resistant.

**C. CANTILEVER TRAFFIC GATES**

1. Contractor to provide (2) two Cantilever Traffic Gates at locations shown on drawings.
2. Steel material for roll gate components (i.e. pales, rails, diagonals and uprights), shall be commercial steel with minimum yield strength of 45,000 psi.
3. Ornamental pale material shall be 2-3/4" wide x 3/4" corrugated pales. Pale spacing shall be 6". Material for top rails, uprights and diagonals rails shall be 2" square x 12 Ga. Material for the bottom rail shall be 2" x 4" x 11 Ga. Posts shall be a minimum of 4" square x 11 Ga. Steel material for fence posts shall be galvanized prior to forming in accordance with the requirements of ASTM A653/A653M, with minimum yield strength of 45,000 psi. The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft<sup>2</sup>, Coating Designation G-90. Depending on application and gate size, material for gate support posts shall be 4" x 11 Ga., or 6" x 3/16".

**D. SWINGING MANUAL TRAFFIC GATES**

1. Contractor to provide (1) one Swinging Manual Traffic gate, at location noted on drawings, with padlock hardware.
2. Steel material for fence framework (i.e., corrugated pales, rails and posts), when galvanized prior to forming, shall conform to the requirements of ASTM A924/A924M, with a minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft<sup>2</sup> (276 g/m<sup>2</sup>), Coating Designation G-90.
3. Material for corrugated pales shall be a nominal 2.75" x .75" x 14 Ga. The cross-sectional shape of the rails shall conform to the manufacturer's Impasse II® rail design a nominal 2" x 2" x 11 Ga. Pre-drilled holes in the Impasse II® rail shall be spaced 4-3/16" on center, providing a pale airspace of no greater than 1-1/2" (38mm). Tamperproof fasteners shall be used to fasten each pale to rail at every intersection. Posts shall conform to the manufacturer's I-Beam design with a nominal 3" x 2.75" x 12 Ga. for fence panel heights up to & including 8' height

## 2.03 FABRICATION

### A. FENCING & PEDISTRIAN SERVICE GATES

1. Pales, rails, and posts shall be pre-cut to specified lengths Rails shall be pre-punched to accept tamperproof security fasteners. Post flange shall be pre-punched to accept rail to post attachment. Post web shall be punched providing a clear opening for interior of rails to align throughout the entire system for affixing conduit, video cabling, IDS wiring, and other components for a complete systems integration. Rails shall be attached to post flange providing a bracket-less design at each intermediate post.
2. Completed panels shall be capable of supporting a 400 lb. load (applied at midspan) without permanent deformation. Panels shall be biasable to a 30° change in grade.
3. A total of (4) four, 42" Wide pedestrian swing gates, shall be fabricated using 2" sq. x 12ga rail, 2" sq. x 12ga. gate ends, and 2.75" x .75" x 0.075 pales. All rail and upright intersections shall be joined by welding. All pale and rail intersections shall also be joined by welding.

### B. PEDISTRIAN ENTRANCE GATES

1. Gate shall be pre-drilled to accept appropriate hardware set. Infill frames shall be fabricated as a single unit. Frame shall be of welded construction inset with perforated metal filler, attachment to gate frame by means of security fasteners.
2. Gate jamb frame shall be fully welded consisting of 3" x 12ga square tubing for main jamb, 1" square gate stop, and strike mounting block, with gate stop bumpers. Jamb to include an electrical access point with conduit point of connection. Electrical connection to gate by means of Power Transfer connection mounted in jamb and gate.
3. Gate shall be pre-assembled.
4. Gate threshold to be mounted with fasteners allowing for placement below grade or removal after gate installation.
5. Gate shall have clear opening (from gate stop to face of gate open to 90 degrees) of 41.5" meeting IBC Group I-2 Egress requirements.

6. Gate hardware to consist of exterior rated devices. Gate and hardware to be pre-assembled prior to shipping.

C. CANTILEVER TRAFFIC GATES

1. Sliding cantilever gates shall match style, height, and color of fence system. The dual enclosed track slide gate shall be an aluminum component design using tracks, uprights, pales, hardware, fittings, and fasteners. Gate installation shall comply with latest ASTM F2200 standards for automated gates.
2. Pales, rails, uprights and posts shall be pre-cut to specified lengths. Diagonals shall be pre-cut to specified lengths and angles. Frame materials shall be joined by welding. Pales shall be face welded to roll gate frame, except for Invincible or Gauntlet style gates over 18' long. Invincible or Gauntlet style gates over 18' long shall have pales face-welded to 2" x 2" angle iron to form panels equal in length to the gate frame bay width.
3. Completed gates shall be capable of supporting a 200 lb. load applied at midspan without permanent deformation.

D. MANUAL SWINGING TRAFFIC GATE

1. Swinging traffic gate shall match style, height, and color of fence system. Gate installation shall comply with latest ASTM F2200 standards for automated gates, regardless of if the gate is of manual operation.

2.04 ACCESSORIES

- A. Caps: Cast steel galvanized or malleable iron galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel in matching finish of fencing.
- C. Gate Hardware: All pedestrian service access gates shall be lockable with a minimum of three (3) 180 degree gate hinges per leaf and hardware for padlock.
- D. Konx box at all gate locations per South King Fire Administrative policy requirements.
- E. Knox padlock on malleable chain at manual swinging traffic gates.

2.04 FINISHES

- A. Factory applied finish, the manufactured galvanized framework shall be subjected to the PermaCoat® thermal stratification coating process (high-temperature, in-line, multi-stage, multi-layer) including, as a minimum, a six-stage pretreatment/wash (with zinc phosphate), an electrostatic spray application of an epoxy base, and a separate electrostatic spray application of a polyester finish. The base coat shall be a thermosetting epoxy powder coating (gray in color) with a minimum thickness of 2 mils. The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils.

PART 3 - EXECUTION

**3.01 INSTALLATION**

A. Fence and Gates shall be installed per manufacturers installation instructions Install.

**B. FENCING**

1. Fence post shall be spaced 96 inches on center per manufacturer requirements. For installations that must be raked to follow sloping grades, the post spacing dimension may be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer. Posts shall be set in concrete footers having a minimum depth of 36".

**C. PEDISTRIAN SWINGING SERVICE GATES**

1. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
2. All gates shall be supported off and between gates posts, adjacent structures shall not be used to support gates or for locking hardware directly.
3. The manufacturers' gate shop drawings shall identify the necessary gate hardware required for the application.
4. Gate hardware shall be provided by the manufacture of the gate and shall be installed per manufacturer's recommendations.

**D. CANTILEVER TRAFFIC GATES**

1. Cantilever support posts shall be set in concrete footers having a minimum depth of 48" Posts shall be spaced according to gate specific submittal drawings. Safety Kit must be included in automated gates.

**E. MANUAL SWINGING TRAFFIC GATES**

1. . For Gates that will be automated, the contractor shall be responsible to ensure the gate, and installation, meet ASTM F2200 and UL325 Standards.

**3.02 ERECTION TOLERANCES**

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.
- C. Components shall not infringe adjacent property lines.

**3.04 CLEANING AND MAINTENANCE**

- A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces.
  1. Remove all metal shavings from cut area.
  2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.



3. Apply 2 coats of custom finish paint matching fence color, utilizing manufacturers paint pens matching fence color to exposed metal surfaces.

\*\*\*END OF SECTION\*\*\*

**SECTION 32 31 11  
GATE OPERATORS**

**PART 1 - GENERAL**

**1.01 REFERENCES**

-

- A. ASTM F2200 - Standard Specification for Automated Vehicular Gate Construction
- B. CAS C22.2 No. 247 Operators and systems of doors, gates, draperies, and louvres
- C. ANSI/UL 325 Door, Drapery, Gate, Louver, and Window Operators and Systems
- D. IFC - International Fire Code, Section 503, Fire Apparatus Access Roads.

**1.02 SUBMITTALS**

- A. Section 01 33 00 - Submittals: Procedures for submittals.
- B. Product Data: Provide product manufactures' data on selected operator, installation procedures and Maintenance instructions.
- C. Shop Drawings: Illustrate Products, installation and relationship to adjacent construction.

**1.03 QUALITY ASSURANCE**

- A. Perform Work in accordance with manufacturer's instructions.

**1.04 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three (5) years documented experience.

**1.05 PRODUCT WARRANTY**

- A. Manufacturer's 5 year Warranty against material and manufacturing defects.

**1.06 ALTERNATES**

- A. See Section 01 23 00 for bidding alternates affecting the work of this Section.

**1.07 COLORS**

- A. Colors are specified on Colors and Materials Schedule on drawings.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURER**

- A. Basis of Design: LiftMaster, model INSL24UL, [www.liftmaster.com](http://www.liftmaster.com)
- B. Substitution: Under provisions of Section 01 60 00.

2.02 MATERIAL

- A. Slide Gate Operators
- B. Operation: Gear driven.
- C. Rated duty cycle: Continuous duty.
- D. Power: 208v single phase, with Transformer kit 3PHCONV at each gate.
- E. Traveling Speed: 6-12 inches per second.
- F. Motor: 24 VDC, continuous duty type, sized to gate conditions.
- G. Battery backup: 33Ah.
- H. Monitoring and controls:
  - 1. A manual override or magnetic spring-loaded opening device shall be provided in the event of a power failure to allow the gate to open.
  - 2. Internet connectivity: MyQ technology with 50 channel FHSS.
  - 3. Access Control: Card Reader and Keypad. Two (2) locations, outside of both gates. Proximity Card Reader
    - a. Refer to Access Control Section 28 13 00.
    - b. Provide all accessories and hardware necessary to provide a fully functional gate system associated with the Access Control System specified for this project.
  - 4. Inground Loop system to exit site, set in final paving lift, not cut into paving afterwards.
  - 5. Monitored safety devices: Thru-beam photo eyes.
  - 6. Plug-in loop detector.
- I. Accessories:
  - 1. Konx box gate toggle switch within a Knox box installed at a location approved at all gate locations per South King Fire Administrative policy requirements.
  - 2. Dual Height Gooseneck Style Access Control Pedestal, Basis of Design: Pedestal Pro Model No. 84-DSP-4-12-12. Finish: Black, Two (2) locations, Located outside of both vehicular gates.
  - 3. 12" Neck Extension with 8x8 face plate at each Card Reader location. Basis of Design Pedestal Pro Model No. 12-EXT-4, Finish Black,
  - 4. Stainless steel housing at each Card Reader location: Basis of Design: Pedestal Pro model No. 68HOU-PPRO-01-304, Finish: Brushed Stainless

PART 3 - EXECUTION

3.01 **INSTALLATION**

- A. Install in accordance with manufacturers instruction.
- B. Test and adjust operators.
- C. Train Owner in proper operation and programing.

\*\*\*END OF SECTION\*\*\*

**SECTION 32 84 00  
IRRIGATION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Piping.
  - 2. Automatic control valves.
  - 3. Sprinklers.
  - 4. Quick couplers.
  - 5. Controllers.
  - 6. Boxes for automatic control valves.
- B. Related Sections:
  - 1. Section 329300 Plants.

**1.02 PERFORMANCE REQUIREMENTS**

- A. General: Furnish and install a completely automatic irrigation system to provide adequate irrigation of all new and restored planting shown on the plans and described in specifications, complete and ready for operation. The work shall consist of providing and installing all material necessary for a complete system, including pipe, valves, fittings, automatic central control equipment, and all appurtenances related thereto. Included shall be all labor for trenching, plumbing, backfill, electrical connections and adjustments, mechanical connections, and other labor necessary for installation of satisfactorily operating systems. Whether mentioned or not, the intent is that the Contractor furnish a complete and operable system as indicated on the drawings.
- B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.

**1.03 SUBMITTALS**

- A. Product Data: Submit product data in accordance with Section 013300 a minimum of 30 working days before beginning work, unless otherwise approved. Include data for all products to be installed in these systems. Include material showing manufacturer's name, catalog numbers, catalog cuts, technical data, and manufacturers' installation, operation, and maintenance instructions for each product.
- B. Wiring Diagrams: For power, signal, and control wiring.

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- C. Zoning Chart: Show each irrigation zone and its control valve.
- D. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
- E. Point of Connection Water Pressure Test: Test water pressure at the irrigation system point of connection prior to beginning work. Submit results of test to Owner's Representative.
- F. Site Inspection Report: Submit statement confirming a site inspection has been conducted, noting discrepancies between ground measures and plans, hazards or site conditions which will interfere with installation or operation of the system prior to beginning of work.
- G. Operation and maintenance data.
  - 1. Submit the name and address of permanent service organizations maintained or trained by the manufacturers that will render service within eight hours of receipt of notification of service request.
  - 2. Zone Map: Submit an irrigation plan for the site indicating, by varying colors, the area of coverage for each control valve. Indicate the number and location of the valve. The number is to correspond to that on the controller for that zone.
  - 3. Submit controller timing schedule indicating on a weekly basis the day, time, and duration of watering for each control valve.
  - 4. Provide the zone map and controller timing schedule for each system, folded into a plastic envelope, of a size capable of being installed in the door of the controller.
  - 5. Submit operating and maintenance guides for the entire system and for each piece of equipment in the system. Instructions for system winterization are to be included.
- H. Record Drawings:
  - 1. Maintain a complete set of record drawings, corrected daily, to show design and specification changes, and location of system components. Submit copies as requested.
  - 2. At completion, submit reproducible Mylar plan at the same scale as the construction plans, indicating the elevations of mainlines, valves, backflow preventers, zone outlines, and other system elements, indicate locations with dimensions from building, curb lines, or other fixed site features.

#### 1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 1.05 PROJECT CONDITIONS

- A. Environmental Requirements: Perform work under environmental conditions suitable for the tasks being undertaken.

- B. Ordinances, Codes, and Regulations: All local, municipal, and state laws, rules, and regulations governing or relating to any of this work are hereby incorporated into and made part of these specifications and their provisions shall be carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with above mentioned rules, regulations, or requirements. Where conflict may occur, rules, regulations, or requirements of the governing code shall be adhered to. However, when these specifications and/or drawings call for or describe materials, workmanship or construction of a better quality, higher standard or larger size, these specifications and/or drawings shall take precedence over the requirements of said rules, regulations, and codes.
- C. Existing Conditions:
1. Visit the site and note conditions which affect work under this Section.
  2. Locate all utilities, lines, and piping in the work area. Provide adequate protection during all phases of work.
  3. Repair utilities, lines, and piping damaged by this work to the satisfaction of the Owner of the line, at no change in Contract Price.
  4. Notify Owner's Representative of unsatisfactory conditions. Proceed with work only after conditions have been corrected.
  5. Field Measurements: Take field measurements of irrigated areas to determine if differences occur between plans and ground dimensions. Notify Owner's Representative of differences before proceeding with work.
  6. Irrigation work is not permitted during the following conditions:
    - a. When the temperature is less than 35 degrees F or greater than 90 degrees F.
    - b. When the planting area's soil is saturated, frozen, or dry.
    - c. When wind velocities are greater than 30 mph.

#### 1.06 MATERIALS AND WORKMANSHIP

- A. General: Whenever any material is specified by name/number, such specifications are for the purpose of facilitating a description of materials and establishing quality, and shall be deemed and construed to be followed by the words "or approved equal." No substitutions will be permitted which have not been submitted for prior approval to Owner's Representative. All materials shall be new, without flaws or defects and shall be the best of their class and kind. Furnish sufficient descriptive literature and/or samples for any material submitted as "equal" substitutes.
- B. Workmanship: All materials and equipment shall be installed in a neat and professional manner. The Owner or Owner's representative reserves the right to direct removal and replacement of any items, which in their opinion do not present an orderly and neat or professional appearance. Such removal and replacement shall be done, when directed in writing, at Contractor's expense without additional cost to Owner.

**1.07 SEQUENCING AND SCHEDULING**

- A. Thirty days prior to beginning work, submit a work schedule to include dates, location, and type of work to be performed.
- B. Complete irrigation system installation and make fully operational before landscape seeding and sodding takes place.

**1.08 WARRANTY**

- A. Refer to the General and Supplementary General Conditions.
- B. Additional Requirements:
  - 1. Repair settling of trenches. Include complete restoration of plantings, mulch, grades, pavements, or other improvements.
  - 2. Correct irrigation system problems or damage within five working days of notice until final acceptance of the irrigation system.

**PART 2 - PRODUCTS**

**2.01 PIPES, TUBES, AND FITTINGS**

- A. Comply with requirements in piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
- B. PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedules 40 and 80.
  - 1. PVC Socket Fittings: ASTM D 2466 Schedules 40 and 80.
  - 2. PVC Threaded Fittings: ASTM D 2464, Schedule 80.
  - 3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.
- C. PVC Sleeves: 6" or 8" class 200 PVC as indicated on the plans.

**2.02 PIPING JOINING MATERIALS**

- A. Solvent Cements for Joining PVC Piping: ASTM D 2564 type 711 gray. No Wet 'n Dry or 725 type cements. Include primer according to ASTM F 656.
- B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Not permitted.

**2.03 MANUAL VALVES**

- A. Brass Gate Valves:
  - 1. Description: Nibco full port threaded brass gate valves, size to match pipe size.



- B. Isolation Ball Valves:
  - 1. Description: Spears threaded schedule 80 PVC, same size as line, with cross-type handle, and fully ported.
- C. Master Valve:
  - 1. Description: Cast-bronze body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-VAC solenoid – Rain Bird EFB-CP Brass.
- D. Control Valves:
  - 1. Description: Rain Bird PED plastic, size per valve key.
- E. Double Check Valve: Febco 825Y, 1-1/2". Install inside an AquaShield Enclosure BFP2-S with dimensions: 46" long, 17" wide and 30" high.

#### 2.04 QUICK COUPLERS

- A. Description:
  - 1. General: Rain Bird 44LRC with locking cap.
  - 2. Quick coupler keys and hose swivel ells, brass, size and type to fit quick coupler.

#### 2.05 SPRINKLER HEADS

- A. General: As described on the Equipment Legend.

#### 2.06 CONTROLLER

- A. Description: Baseline BL-3200XS 2-wire controller, wall mounted.
- B. Weather Sensor: Baseline BL-5407-KIT

#### 2.07 FLOW SENSOR

- A. Flow Sensor: Baseline BL-BFM100, 1" flow sensor with integrated flow decoder and 2-wire ready.

#### 2.08 LOW VOLTAGE CONTROL WIRE AND CONNECTORS:

- A. Control Wire: Wire, solid copper, UL listed for direct burial in ground, minimum size #14 AWG. Install in a looped configuration.
- B. Wire Connectors: 3-M DBY or DBR waterproof electrical connectors.
- C. Control wires shall be color coded as follows:
  - 1. Two-wire - Blue.
  - 2. Spare wire – Orange.
  - 3. Control wires to be installed in 1-1/2-inch minimum PVC schedule 40 sleeve under all paved areas.

- D. 2-wire Decoders:
  - 1. Description: Baseline models Description: Baseline models BL-5201MV (Master valve), BL-5201PR (Pump start/stop), and BL-5201 (One station) biCoders.
- E. Grounding:
  - 1. Description: The 2-wire path shall be surge-protected with one BS-LA01 lightning arrester every 500 feet or every 8 decoders, whichever is smaller.

## 2.09 TRACER WIRE

- A. Tracer wire to be #14 AWG solid copper with blue polyethylene jacket for direct burial.

## 2.10 VAULTS

- A. Plastic Boxes:
  - 1. Description: Control valve boxes to be Carson/Oldcastle Pro Series vaults as detailed, Carson extensions as required. Quick coupler boxes to be Carson Pro Series 10" round vaults. All boxes to have locking T-type covers, bolt installed.

## 2.11 OTHER MATERIALS

- A. Drain Rock: Cleaned gravel or round stone, graded from 3/4 inch minimum to 1-1/2 inches maximum, no fines.
- B. Trench Backfill: Masons sand.
- C. "Air Compressor" Valve: Size to fit quick coupling valve keys.
- D. Valve Keys, 3 feet long (minimum), with tee handle and key end to fit manual valves.
- E. Quick Coupler Keys and Hose Swivel Ells: Brass, size and type to fit quick coupler shown on Drawings.
- F. Data Cable: Cat6 direct burial ethernet cable.
- G. Detectable Marking Tape: Christy's 3" detectable marking tape consists of a minimum 5 mil overall thickness; five-ply composition; ultra-high molecular weight; 100% virgin polyethylene; acid, alkaline and corrosion resistant. The tape shall have a 20-gauge solid aluminum foil core, encapsulated within 2.55 mil polyethylene backing. Tape tensile strength shall be in accordance with ASTM D882-80A and be not less than 7,800 psi. Tape Legend: Caution Irrigation Line Below. TA-DT-3-GI.
- H. Valve Markers: Christy's Identification Tags manufactured from polyurethane Behr Desopan, incorporating an integral attachment neck and reinforced attachment hole and will be capable of withstanding 180 lbs. Pull force. Tag shall be approximately 2.25" x 2.75" in size. All lettering will be hot stamped in black and capable of withstanding outdoor usage. The standard alphanumeric designations shall incorporate lettering 1 1/8" in height. Tag color will be yellow. Marking tag will be double side stamped with zone valve number.
- I. All other materials, not specifically described but required for a complete and proper irrigation system installation, shall be new, first quality of their respective kinds, and subject to approval of Owner or his representative:

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.02 PIPING INSTALLATION

- A. Protection: The Contractor shall exercise care in handling, loading, unloading, and storing to avoid damage. The pipe and fittings shall be stored under cover and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat, so as not to be subject to undue bending or concentrated external load at any point. Any pipe that has been dented or damaged shall be discarded until such damage has been cut out and the pipe is rejoined with a coupling.
- B. Installation: No piping shall occur unless the Point of Connection is installed and water is available for flushing.
- C. All pipe within buildings to be installed by Mechanical.
- D. All pipe over 2-1/2" diameter shall be installed with thrust blocks.
- E. Trench Depth: Excavate straight trenches to a depth of 3" below invert of pipe, unless otherwise indicated. Unless otherwise specified, trenches shall be deep enough to allow 12" cover over lateral lines and 18" cover over supply main lines. 24" maximum cover. All trenches must be straight and not have abrupt changes in grade. Excavate straight and true with bottom uniformly sloped to low points. Trench bottoms with uniform slope, free of rocks or sharp-edged objects. Install pipe with label facing up.
- F. Tracer Wire: install tracer wire with the main line over the entire length. Only splice wire in a valve box using 3M DBY or DBR splice kits. Ground the tracer wire by the POC. Provide access to tracer wire at isolation valve boxes.
- G. Route irrigation lines around roots of existing trees. Care shall be exercised by the Contractor when excavating trenches near existing trees. Trenches having exposed tree roots shall be backfilled within 24 hours unless adequately protected by moist burlap or canvas directed by the Owner's Representative. Pipe shall lay side by side in trench. No stacking of pipe permitted.
- H. Paved Areas: Sleeve all pipe under paved areas.
- I. Backfill: Backfilling shall be done when pipe is not in an expanded condition due to heat or pressure. Cooling of the pipe can be accomplished by operating system for a short time before backfilling, or by backfilling in the early part of the morning before heat of the day. Backfill shall contain no lumps or rocks larger than 1 inch.

- J.        Compaction: Use hand-operated plate type vibratory or other suitable hand tampers in areas not suitable for larger rollers or compactors. Compact initial backfill material surrounding pipes and conduit to 90 percent maximum density. For pipes, conduits and sleeves under roads and slabs, compact backfill as specified herein for other utilities under roads and slabs. General: Install in a manner so as to provide for expansion and contraction as recommended by manufacturer. Cut plastic pipe to ensure a square cut. Remove burrs at cut ends prior to installation. Install piping free of sags and bends. Solvent-weld or slip seal all plastic joints. Only solvent recommended by pipe manufacturer shall be used. Install all plastic pipe and fittings as shown and instructed by pipe manufacturer. Install with label facing up. Contractor shall assume full responsibility for correct installation.
- K.        Install groups of pipes parallel to each other, spaced minimum 6" apart to permit servicing.
- L.        Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.

### 3.03 JOINT CONSTRUCTION

- A.        Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- B.        Joints: All plastic to metal joints shall be made with plastic Schedule 80 male adapters. Care should be taken at solvent joints not to use an excess amount of solvent. Allow PVC joints to set at least 24 hours before pressure is applied to system. Use pre-primer at joints.
- C.        PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1.        Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2.        PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855. Use purple primer and type 705 gray or 721 blue glue. No Wet 'n Dry or type 725 or 738 glue.
  - 3.        PVC Non pressure Piping: Join according to ASTM D 2855.

### 3.04 BACKFLOW PREVENTER

- A.        General: Install per local water district code requirements and per manufacturer's instructions. Contractor shall provide power for the heating unit.
  - 1.        Stake location for approval by Landscape Architect prior to installation.
  - 2.        Connect to the new water meter and install a stop waste valve.
  - 3.        Install vertical plumbing, electrical conduit, ground rod, and manual drain before pouring concrete pad.
  - 4.        Install concrete pad. See Drawings for size.
  - 5.        Install plumbing and electrical.

6. Mount enclosure securely to concrete pad per manufacturer's instructions.
7. Test RPBA and provide a test report.

### 3.05 VALVES

- A. General: Stake location of all valve boxes for approval prior to installation. Install as detailed on plans. Before installation, the supply line must be thoroughly flushed. Use valve box extensions to ensure that box extends completely below the bottom of the valve. Wire loops required at all valve boxes. Install locking cover bolts. Use Teflon tape only, no pipe dope.
- B. Use factory solenoid as detailed.

### 3.06 IRRIGATION HEADS

- A. General: Install all heads as detailed on drawings, adjusting location as necessary to achieve maximum coverage as intended. Heads adjacent to walks, walls or curbs and other paved areas shall be set 4-inches from edge of paving. Balance and adjust all nozzles after entire system is operable. Set heads perpendicular to finish grade unless otherwise indicated.
- B. Adjustment: All nozzles on stationary sprinklers or spray heads shall be tightened after installation. All sprinklers having an adjusting screw, adjusting stem or adjusting friction collars shall be adjusted on a lateral line of circuit as required for proper arc, coverage, radius, diameter, and/or gallonage discharge.

### 3.07 AUTOMATIC IRRIGATION CONTROL SYSTEM

- A. Equipment Mounting: Wall mount controller as directed by Landscape Architect.
- B. General: Install electrical Control Wire and Conduit as shown on drawings and/or specified. No splices of wires between valves and controller. Electrical wiring (120 VAC) shall be installed according to local code. A licensed electrician must perform hard wiring of controller(s), and the work must be permitted per City requirements. The cost of all electrical work necessary to make the automatic equipment operate properly shall be included in this contract.
- C. Conduit for power supply wires shall be installed as shown on Plans and Details and controller manufacturers shop drawings. The ends of all conduits, whether shop cut or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true. Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. A 3/16-inch polyethylene pull rope shall be installed in all conduits with two feet of pull rope extended beyond the conduit openings and then secured. All conduit shall be free of debris. All conduit openings shall be sealed with duct tape to prevent fouling.
- D. Connections at Controller: Each control valve is connected to one station of controller and has wire sizes as shown or as specified. Provide separate common ground wire system. Provide junction box at controller location for connection. Connect master valve to master valve start circuit on controller.
- E. Central Control: Install system per manufacturer's recommendations, including wiring, grounding, decoders, and lightning arresters (base bid), wire connectors, and all other equipment necessary to install a fully functional system.
- F. Underground Splices: Vinyl insulated connectors and sealed in epoxy resin. Splices to be made in electrical junction boxes. 3M-DBY or approved.

- G. Data Cable: Install Cat6 cable from controller to inside operations building where it can connect to the network. Coordinate this work with the IT department. Install Cat6 cable within mainline trench.

### 3.08 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. As-Builts: Draft and up to date as-built drawings are required on site for all testing and inspections.
  - 2. Schedule: Provide 4 days' notice for test requests.
  - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist. Request no tests until confident work will pass.
  - 4. Main Line Pressure Test: After flushing is complete, pressure test mainline with all valves installed in operating order (flow control in working position), and associated isolation valves open, to 150 psi. System will pass test when it maintains less than 5% drop in a 30-minute time period in presence of Owner's Representative. Main line will be tested as one integral and complete unit at the time of the Punch List. Subsequent breaks or other breaches of mainline integrity require retesting of entire mainline.
  - 5. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
  - 6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 7. Perform a water coverage test in presence of Owner's Representative to determine whether water coverage and operation of system is adequate for planting. If system is determined by Owner's Representative to be inadequate due to poor workmanship or materials, replace or repair and test repeated until accepted. Dry spots will not be acceptable.
- B. Irrigation products will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.09 ADJUSTING

- A. Adjust settings of controllers.
- B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.
- C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch above, finish grade.

### 3.10 PROTECTION

- A. Deactivate and drain system prior to onset of freezing season and reactivate at onset of spring season. Accomplish each at least once during warranty period. If construction is completed when system is not in use, winterize after testing. Certify by letter dates of winterization / activation. Repair damage from failure to comply.

- B. When using compressed air to winterize the system, do so in short cycles at no more than 40 psi air pressure. Do not allow pipe close to the compressor to get hot to the touch.

\*\*\*END OF SECTION\*\*\*

**SECTION 32 84 11  
IRRIGATION BOOSTER PUMP**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Performance and material requirements for the design and installation of an efficient and fully automatic irrigation system.
- B. Related Sections:
  - 1. Division 01 Section "Summary" for description of work by others.
  - 2. Division 15 Sections involving plumbing for irrigation system.
  - 3. Division 16 Sections involving electrical for irrigation system.
  - 4. Division 32 Section "Irrigation."

**1.02 REFERENCES**

- A. ANSI B58.1.
- B. ASTM 48, Class 30.
- C. NEC.
- D. NEMA Standards.

**1.03 WORK INCLUDED**

- A. The Work covers a complete pump system including all required design criteria; installation of pipe, valves, fittings, and all other appurtenances; connections to water; testing; installation of controller(s), electrical connections, and wiring; and system fine tuning. Coordinate all Work with other trades.

**1.04 REQUIREMENTS**

- A. Work and materials shall be in accordance with the latest rules, regulations and other applicable state or local plumbing, electrical and health codes. Nothing in the Contract Documents is to be construed to permit Work not conforming to these codes.
- B. Obtain and pay for all permits, approvals, and inspections required by the local jurisdictional authorities for the full operation of the system.

**1.05 SUBMITTALS**

- A. Refer to Division 01 for general submittal requirements.



- B. Product Data: Submit product data before beginning work. Include manufacturer's product literature for all products to be installed in this system. Include material showing manufacturer's name, catalog numbers, catalog cuts, technical data, installation, and operation and maintenance instructions for each product.
- C. Point of Connection Water Pressure Test: Test water pressure at point of connection. Verify pressure is in the range indicated on the construction drawings. Submit written results of test to the Landscape Architect.
- D. Maintain a current record of all pipe and equipment placement and record any variations approved by the Architect. Upon completion of the system and prior to release of final payment, provide a neat and legible record drawing of the completed system. Any pipe not installed in accordance with the plans as originally contracted shall be sufficiently dimensioned to a permanent structure for location after burial. Update record drawings DAILY.
- E. Maintenance Manuals: Provide minimum of two (2) operation and maintenance manuals. The manuals shall be indexed and tabbed, bound in hardback three-ring binders. Include the following items/information:
  - 1. List of authorized distributors and service representatives (in the area) for each item of irrigation equipment: include names, addresses, and phone numbers.
  - 2. Guarantee/warranty certificates for all equipment used and Contractor's written warranty for entire system one (1) year guarantee.
  - 3. Manufacturer's maintenance sheets, replacement parts list and equipment brochures for all equipment used. All composite data sheets shall have the specified products used in the field clearly highlighted.
  - 4. Winterization and spring start up procedures.

**1.06 SUBSTITUTIONS**

- A. Substitutions will be considered during the bid process per Specification Sections.

**1.07 QUALITY ASSURANCE**

- A. The work is subject to tests and inspections by the Landscape Architect as specified. Furnish written notice to the Landscape Architect one week prior to the required test or inspection.

**1.08 PROJECT CONDITIONS**

- A. Underground Utilities and Elements: Locate all underground utilities and elements prior to digging and/or driving stakes. Take care to neither disturb nor damage any existing aboveground or underground utilities or elements. Keep streets, sidewalks, and site clean, free from debris, and affected drains open and free flowing at all times.
- B. Site Inspection and Layout: Before proceeding with any work, inspect the site, carefully check all grades, and verify all dimensions and conditions affecting the work in order to proceed. Changes or alterations to the system to meet actual conditions shall be made at the Contractor's expense.

**1.09 DELIVERY, STORAGE, HANDLING AND PROTECTION**

- A. Protect work and materials from damage during construction and storage.

- B. Assume all responsibility for damage to adjacent construction and restore to its original condition should damage occur as a result of this work.

#### 1.10 WARRANTY

- A. The manufacturer shall warrant the water pumping system to be free of defects in material and workmanship for a period of 24 months from date of authorized start-up, not to exceed 30 months from date of manufacturer invoice of ready to ship.

#### 1.11 SYSTEM FAMILIARIZATION

- A. Before final acceptance of the system, provide the necessary keys and/or other tools required to operate, drain, and activate the system. Provide two (2) complete sets of tools and keys to the Owner.
- B. Provide the following minimum standards of training with the Owner's personnel before final acceptance of the system.
  1. Pump station operation and maintenance - 4 hours on site.

### PART 2 - PRODUCTS

#### 2.01 SUMMARY

- A. All materials used throughout the system shall be new, unused, and in perfect condition. Refer to the irrigation materials legend, notes, detail drawings and these specifications for specific equipment to be used. Equipment or materials installed or furnished without prior approval of the Landscape Architect may be rejected and the Contractor will be required to remove such materials from the site at his own expense.

#### 2.02 BOOSTER PUMP SYSTEM

- A. Munro Systems Model #SIMP46053PHBP; Grand Junction, Colorado. Available from HD Fowler, Julia Wiebenga (425-864-6344). Pump station shall be capable of producing 80 gpm at 56 psi boost for a total operating pressure of 85 psi. Station shall be provided 480v, 3ph service power with a minimum feeder rated at 75 amps.

#### 2.03 PUMP

- A. Volute: Volute shall be of heavy-duty cast iron ASTM-A48. NPT threaded pipe connections shall be standard. Volute shall be capable of withstanding maximum working pressures of 150 psi. Discharge orientation shall be in the vertical position. 1/4" NPT plugged pipe taps will be available for draining of the volute.
- B. Impeller: All impellers shall be of enclosed design and balanced for smooth, vibration free operation. Impellers shall be of bronze, ASTM B124.
- C. Mechanical shaft seal: The shaft seal assembly shall be composed of a Carbon rotating face, Ceramic stationary, Nitrile elastomer and 300 series stainless steel hardware as standard. Temperature rating shall be 212°F maximum.
- D. Shaft sleeve: The shaft sleeve shall be a slip-fit, replaceable o-ring design.

**2.04 MOTOR**

- A. The pump drive motor shall be of a NEMA standard design, 182JM frame, ODP, footed, close-coupled. Motors shall be of manufacturers standard catalog design. The motor rating shall be: 5 hp, 230/460 volt, 3 phase.

**2.05 PUMP STATION SKID**

- A. The pump station base shall provide proper structural support for all attached equipment and shall provide sufficient rigidity to withstand the stresses from reasonable transportation to site, off-loading, installation, and operation.
- B. The main structural members shall be constructed from medium weight channel aluminum.
- C. The pump station skid shall incorporate into its structure provisions for off-loading and handling at the site of installation. These lifting points shall be an integral part of the structure.

**2.06 ENCLOSURE**

- A. The pump station enclosure shall be weather resistant and manufactured entirely of marine-grade aluminum. The enclosure shall have a lockable, hinged door for easy compartment access. Ventilation louvers shall be mounted in the enclosure. The ventilation louvers shall have rodent protective guards. The enclosure shall be powder coated Desert Tan.

**2.07 PIPING**

- A. All piping shall be ASTM A53 Schedule 40 pipe.
- B. Manifold piping shall be 3" carbon steel.
- C. Piping shall be assembled by means of mechanical groove fittings.
- D. The structural base, piping and supports shall be cleaned and coated with an electrostatic epoxy. The finish coat shall be polyester to a thickness of no less than 3 mills.
- E. A manual flow bypass shall be incorporated in the piping manifold.

**2.08 PUMP CHECK VALVE**

- A. The pump station shall have a check valve bolted to the pump discharge, sized so that pressure drop does not exceed 2.0 psi.
- B. Check valves shall be of the swing operating type with built in spring.

**2.09 PUMP ISOLATION VALVES**

- A. The pump shall be equipped with a groove fitted butterfly isolation valve.
- B. Isolation valve shall be sized as shown on the technical data sheets.

**2.10 GAUGES**

- A. Pressure and vacuum gauges shall be mounted on the suction and discharge header on top of an isolation ball valve.

- B. Gauges shall be silicon filled, accurate within 2% and 2 1/4" in diameter.
- C. Range shall be at least 30% higher than the highest pressure attainable from the pumps at shutoff head conditions.

**2.11 PUMP STATION ISOLATION VALVE**

- A. An isolation valve of the same line size as the discharge spool shall be installed on the outlet of the pump station to allow for complete isolation of the pump station from the irrigation system.
- B. The valve shall be of the groove style butterfly type with a one-piece body cast from ASTM A536 ductile iron.
- C. The valve shall have a lever operator and shall be rated at 175 psi.
- D. The station isolation valve shall be as manufactured by Munro.

**2.12 ELECTRICAL**

- A. Circuitry
  - 1. The control panel shall include all logic circuitry to provide for the timed sequence, start-up, and shutdown of all pumps. A pump start relay shall be provided for an alternate starting option.
  - 2. All relays, terminal strips, and other necessary equipment shall be enclosed in a Type 1, U.L. approved enclosure.
  - 3. The following features shall be included as standard:
    - a. Loss of prime safety.
    - b. Phase unbalance, phase reversal, loss of phase protection.
    - c. Low voltage safety protection.
  - 4. The control panel shall include all magnetic starters, relays, transformers, pressure sensors and various safety devices for the operation and protection of the pumping station.
  - 5. A custom logic program embedded in the VFD controller shall be provided to perform the sequence of operation. Use of PLCs is not acceptable.
- B. Control Enclosure
  - 1. Control interface equipment shall be housed in a Type 1 enclosure.
- C. Service Disconnect
  - 1. Provisions shall be to completely isolate all control and motor starting equipment from incoming power by a non-fused disconnect of adequate size.
  - 2. A service disconnect shall be mounted inside the station enclosure.

D. Variable Frequency Drive

1. The variable speed drive shall be a digital, pulse width modulation (PWM) variable frequency drive (VFD) with Insulated Gate Bipolar Transistors (IGBTs).
2. The VFD shall have a minimum wire-to-wire efficiency of 98%, and shall be rated up to 230-volt single-phase operation in order to eliminate nuisance tripping at marginally high voltage conditions. Fast acting semiconductor fuses shall protect front end.
3. Any VFD error messages shall be displayed on an eight-language removable digital operator with an illuminated LCD display.
4. The following fault protection circuits shall be included:
  5. Over Current 150% of rated FLA (Full Load Amps) for 60 seconds for Heavy Duty applications
  6. 120% of rated FLA for 60 seconds for Normal Duty applications
  7. 200% of rated FLA peak, overheat, motor overload, VFD overload, short circuit, overvoltage, undervoltage, input phase loss, output phase loss and output ground fault.
8. The VFD shall be capable of starting into a rotating load and accelerate or decelerate to set point without safety tripping.
9. The following operating information shall be displayed on the VFD LCD: KWH, elapsed time, output frequency (Hz), motor speed (RPM), motor current (amps), and voltage.
10. VFD shall be as manufactured by Yaskawa, model V1000 VFD.

E. Pressure Transducer

1. A pressure transducer shall be installed to transmit all pressure signals to the VFD controller.
2. The pressure transducer shall be a solid-state bonded strain gage type with accuracy of plus/minus 0.50%.
3. All wetted parts of the pressure transducer shall be constructed of stainless steel. Plastic is not permitted.
4. The pressure transducer shall be installed downstream of an isolation ball valve for easy service.
5. The pressure transducer shall be rated for the station discharge pressure.

2.13 WIRING

- A. The main control panel disconnect shall be feed by a 25 AMPS, 460/60hz/3PH service line from the pump house electrical entrance.

2.14 PAINT AND RUST PROTECTION

- A. All structural steel, piping, and supports shall be abrasive blasted to a near white metal condition, and promptly coated with a polyester powder coat.

PART 3 - EXECUTION

3.01 START-UP SERVICE

- A. When discharge piping, electrical connections, and electrical inspection have been completed, the pump station manufacturer shall be contacted for start-up. A two-week notice shall be given to the manufacturer prior to scheduled start-up date. During start-up, the complete pumping system shall be given a running test of normal start and stop, and fully loaded operating conditions. During this test, the pump shall demonstrate its general ability to operate without undue vibration or overheating, and shall demonstrate its general fitness of service. All defects shall be corrected and adjustments shall be made for proper operating system. After station start-up has been completed and accepted, a training session shall be given to the owner or owner's representative familiarizing that person with pumping system operations, maintenance, and adjustments. Minimum start-up assistance, exclusive of travel time, shall be one 8-hour day. Provide for minimum of an 8-hour training session, exclusive of travel time, in addition to the start-up assistance. Start-up and training assistance shall be by the manufacturer's technical service agent.
- B. A minimum of five (5) working day notice shall be provided to manufacturer's technical service agent for start-up of pump station.

\*\*\*END OF SECTION\*\*\*

**SECTION 32 91 15  
SOIL PREPARATION**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section includes planting soils specified according to performance requirements of the mixes.
- B. Related Requirements:
  - 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
  - 2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
  - 3. Section 329300 "Plants" for placing planting soil for plantings.

**1.03 DEFINITIONS**

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil, as indicated.
- B. CEC: Cation exchange capacity.
- C. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- D. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- E. Imported Soil: Soil that is transported to Project site for use.
- F. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- G. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- I. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

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- J. SSSA: Soil Science Society of America.
- K. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- L. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- M. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- N. USCC: U.S. Composting Council.

#### 1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.05 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include test data substantiating that products comply with requirements.
  - 2. Include sieve analyses for aggregate materials.
- B. Samples: For each bulk-supplied material, 1-gal. volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.
- C. Qualification Data: For each testing agency.
  - 1. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
- D. Compaction Testing Reports.
- E. Field quality-control reports.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.



3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

## PART 2 - PRODUCTS

### 2.01 PLANTING SOILS

- A. Planting Soil, Type A (Turf Areas): Manufactured soil consisting of 60% sand, according to USDA textures, and 40% compost blended in a manufacturing facility with stabilized organic soil amendments and other materials to produce viable planting soil.
  1. Additional Properties of Manufacturer's Basic Soil before Amending:
    2. Sand shall meet to the following:
      3. 100% passing 3/8-inch sieve.
      4. 50-80% passing #10 sieve.
      5. 10-30% passing #40 sieve.
      6. 0-5% passing #200 sieve.
    7. Compost shall meet requirements of Article 2.3.A.
    8. pH between 6 to 7.5.
    9. Organic matter content between 4 and 8 percent by weight (Loss on Ignition method).
    10. Soluble salt contents less than 3.0 hos/cm.
    11. Friable and with sufficient structure to give good tilth and aeration.
  12. Unacceptable Properties: Manufactured soil shall not contain the following:
    13. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    14. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
    15. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
      - a. Approved products include Cedar Grove's "60/40 Lawn Mix."

- B. Planting Soil, Type B (Shrub Areas): Manufactured soil consisting of 50-65% sand and sandy loam, according to USDA textures, and 35-50% compost blended in a manufacturing facility with stabilized organic soil amendments and other materials to produce viable planting soil.
1. Additional Properties of Manufacturer's Basic Soil before Amending:
  2. Sand shall meet the following:
    3. 100% passing 3/8-inch sieve.
    4. 50-80% passing #10 sieve.
    5. 10-30% passing #40 sieve.
    6. 0-5% passing #200 sieve.
  7. Loam shall be Sandy Loam per USDA gradation and meet the following:
    8. 90-100% passing 1/2-inch sieve.
    9. 75-90% passing #4 sieve.
    10. 45-60% passing #20 sieve.
    11. 20-40% passing # 60
    12. < 30% passing #200 sieve.
  13. Compost shall meet requirements of Article 2.3.A.
  14. pH between 6 to 7.5.
  15. Organic matter content between 10 and 15 percent by weight (Loss on Ignition method).
  16. Soluble salt contents less than 3.0 hos/cm.
  17. Friable and with sufficient structure to give good tilth and aeration.
  18. Unacceptable Properties: Manufactured soil shall not contain the following:
  19. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
  20. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
  21. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
    - a. Approved products include Cedar Grove's "3-Way Topsoil."

**2.02 INORGANIC SOIL AMENDMENTS**

- A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
  - 1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
  - 2. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
  - 3. Form: Provide lime in form of ground dolomitic limestone or calcitic limestone.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- E. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

**2.03 ORGANIC SOIL AMENDMENTS**

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
  - 1. Feedstock: May include sewage sludge.
  - 2. Reaction: pH of 5.5 to 8.
  - 3. Organic-Matter Content: 50 to 60 percent of dry weight.
  - 4. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.
- B. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
  - 1. Partially Decomposed Wood Derivatives: In lieu of shredded and composted wood derivatives, mix shredded and partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. of loose sawdust or ground bark.

**2.04 FERTILIZERS**

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
  2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

### PART 3 - EXECUTION

#### 3.01 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

#### 3.02 SUBGRADE PREPARATION:

- A. Completely remove and dispose of all structural fill, gravel, quarry spall, construction debris, and other obstructions in the area to receive planting, including areas where native soils have been removed and replaced with structural materials adjacent to buildings and paved areas. Remove debris and rocks over 4 inches in size to a depth of at least 12 inches in all areas to receive planting.
- B. If native soil in areas to receive planting is free from structural fill, gravel, quarry spall, construction debris, and other deleterious materials, establish subgrade lines and grades appropriate to provide for specified depth of prepared planting soil.
- C. If subgrades need to be raised to establish lines and grades appropriate to provide for specified depth of prepared planting soil, use accepted Engineered Fill as defined in Section 31 20 00, Earthwork.
- D. After subgrade lines and grades are established, scarify exposed soils in two directions to a depth of at least 12 inches. Entire surface shall be disturbed by scarification. Moisture control if necessary. Do not scarify within drip line of existing trees to remain. Tilling with a backhoe bucket is not an acceptable method. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- E. Obstructions Below Grade: In the event that roots, rocks, underground construction work, utilities, or obstructions are encountered during scarification operations under this Contract, continue work by hand with shovel or fork.

- F. Finish subgrades will be reviewed by Owner's Representative before placing soil amendments or manufactured planting soil.

**3.03 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE**

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Application:
- C. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 4 inches of subgrade.
- D. Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Lifts: Apply planting soil in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- E. Compaction: Compact each lift of planting soil to 85 percent of maximum Standard Proctor density according to ASTM D698.

**3.04 BLENDING PLANTING SOIL IN PLACE**

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Application: Spread compost to total depth indicated on Drawings and fertilizer, if required, evenly on surface, and thoroughly blend into 6 inches of unamended, in-place soil to produce planting soil.
  - 1. Mix fertilizer with planting soil no more than seven days before planting.
- C. Compaction: Compact blended planting soil to 85 percent of maximum Standard Proctor density according to ASTM D698.

**3.05 FINISH GRADING:**

- A. After natural settlement and light rolling, complete work to conform strictly to the lines, grades, and elevations indicated. Elevations and landform configuration is critical to project design intent. Supply additional soil as needed to give the specified depths and grade.
- B. Grades in planting areas not otherwise indicated shall have uniform levels or slopes between points established by pavements, curbs, catch basins, or other utility lids. Finish grade shall be smooth, even, and on a uniform plane with no abrupt change in surface and have no erosion scars.
- C. Slope all planting areas to drain. If drainage conditions are questionable, request review and direction from the Owner's Representative. Adjustments to accommodate drainage concerns must be approved by the Owner's Representative. Drainage problems discovered after plant material is installed shall be corrected to the satisfaction of the Owner's Representative as part of the Contract.
- D. Ensure finish grading accounts for depth of mulch in relation to adjacent grade conditions.

- E. Protect all planting areas against compaction by construction equipment.

**3.06 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests:
  - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698. Space tests at no less than one for each 2,000 sq. ft. of in-place soil or part thereof.
  - 2. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
- C. Soil will be considered defective if it does not pass tests.
- D. Prepare test reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

**3.07 PROTECTION**

- A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- B. If planting soil or subgrade is over compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

**3.08 CLEANING**

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
  - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

\*\*\*END OF SECTION\*\*\*

**SECTION 32 92 00  
TURF AND GRASSES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Scope of work:
1. This section describes the preparation, amendments, and seeding and or sodding of the areas as shown on the plans.
  2. The surfaces must be established and stabilized to finish grade and approved by the Landscape Architect, prior to commencing with seeding the process.
  3. The Contractor shall maintain the turf areas until the Owner's representative or Landscape Architect accepts the project as satisfactory.
- B. Section Includes:
1. Hydroseeding.
  2. Sodding.
- C. Related Work:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  2. Section 328400 "Irrigation" for turf grass area irrigation.
  3. Section 321243 "Porous Flexible Paving" for porous pavement systems seeded with turf grasses.
  4. Section 321913 "Soil Preparation" for turf grass soil mix, amendments, and placement requirements.
  5. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

**1.02 DEFINITIONS**

- A. Finish Grade: Elevation of finished surface of planting soil, prior to seeding. For sod placement, finished grade is the elevation of the top of sod soil. See details for exceptions adjacent to paving for drainage.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.



- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- F. Planting Substantial Completion: Seeded and sodded areas have been reviewed and approved by Landscape Architect and found to meet requirements.

### 1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Agenda Items:
  - 1. Review of soil elevation, fine grading, and preparation.
  - 2. Irrigation installation completion and coverage.
  - 3. Weather conditions.
  - 4. Sod storage.

### 1.04 SUBMITTALS

- A. Qualification Data: For landscape Installer indicating the information required in the Quality Assurance section.
- B. Product Data Submittals: For each product, seed mix, or sod type indicated prior to ordering.
  - 1. Include quantities, sizes, quality, and verified sources of materials.
  - 2. Include seed species and ratios.
  - 3. Substitutions shall be made in accordance with Division 01 specifications.
- C. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
  - 1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- D. Product Certificates: For fertilizers, from manufacturer.
- E. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

**1.05 CLOSEOUT SUBMITTALS**

- A. Owner Maintenance Schedule: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.
  - 1. Include product data sheets in manual, along with maintenance instructions and parts lists for those products.
- B. Contractor Maintenance Schedule: Provide dates and tasks to be performed, per specification requirements. Schedule to be provided when maintenance begins.
- C. Maintenance Report: Confirmation that scheduled maintenance visits were performed, with notes on challenges encountered. Reports to be provided to Landscape Architect and owner's representative every month of maintenance period.

**1.06 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
  - 1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals, AmericanHort, American Nursery and Landscape Association, or the Washington Association of Landscape Professionals.
  - 2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Pesticide Applicator: State licensed, commercial, and familiar with EPA standards.

**1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable. Damaged packages will not be accepted.
  - 1. Seed shall be stored under cool and dry conditions so that endophytic seed in the mixture is capable of maintaining a high level of endophytes.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  3. Accompany each delivery of bulk materials with appropriate certificates.
- D. Deliver fertilizer in sealed waterproof bags, printed with manufacturer's name, weight, and guaranteed analysis.

#### 1.08 FIELD CONDITIONS

- A. Planting Restrictions: Plant seed during the following period. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
1. From March 15 to October 15 or as approved by Landscape Architect. All seeding must be complete prior to project substantial completion date.
  2. Seeding and sodding may only be done after the irrigation system is installed and operational.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained, unless approved by owner's representative. Apply products during favorable weather conditions according to manufacturer's written instructions. Do not plant during the following conditions unless approved.
1. Cold weather: when ambient temperature is below 40 degrees F.
    - a. For grass seed: when soil temperature is less than 50 degrees F.
  2. Hot weather: when temperature exceeds 90 degrees F.
  3. Windy weather: for seed when wind velocity exceeds 30 mph.
  4. Observe any additional limitations noted by manufacturer.
- C. Soil Conditions- Proceed with planting only when existing soil conditions permit planting to be performed when beneficial and optimum results may be obtained, unless approved by Landscape Architect. Do not plant during the following conditions unless approved.
1. When soil is saturated.
  2. When soil is frozen.
  3. For grass seed: when soil temperature is above 65 degrees F.

#### PART 2 - PRODUCTS

##### 2.01 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Seed Law – All seeds shall conform to the requirements of the Washington State Seed Law and, where applicable, the Federal Seed Act.
2. Noxious Weed Seed – All seed shall be free of seeds listed as primary noxious by the Washington State Seed Law. Seeds shall not contain seeds of weeds listed as secondary noxious by the Washington State Seed Law, singly or collectively, in excess of the labeling tolerance specified by the Washington State Seed Law.
3. Rejection – When seeds furnished under this Specification fail to meet the requirements within tolerance as provided by the Washington State Seed Law, the lot shall be rejected.
4. Preparation for Delivery – Seeds shall be packed in clean, dry, solid containers of uniform weight. Seed shall be labeled as required by law.
5. Grass & Wildflower Mix:
  - a. 71% Grasses:
    - 1) 31% Perennial Ryegrass
    - 2) 20% Hard Fescue
    - 3) 20% Sheep Fescue
  - b. 29% Flowers:
    - 1) 7.5% White Yarrow
    - 2) 6% White Clover
    - 3) 4.5% Pacific Lupine
    - 4) 3% Strawberry Clover
    - 5) 3% California Poppy
    - 6) 2% Sweet Alyssum
    - 7) 1.5% Shasta Daisy
    - 8) 1.5% Farewell to Spring
    - 9) Seeding rate: 3 lbs per 1,000 sq. ft.
6. Western Washington Shade Mix:
  - a. 60% Perennial Ryegrass.
  - b. 40% Fine Fescue.
  - c. Seeding rate: 5-7 lbs per 1,000 sq. ft.
7. Wet Area Seed Mix:
  - a. 60% Tall or Meadow Fescue / *Festuca arundinacea* or *Festuca elatior*
  - b. 15% Creeping Bentgrass / *Agrostis palustris*
  - c. 15% Meadow Foxtail / *Alepocurus pratensis*
  - d. 5% Alsike Clover / *Trifolium hybridum*

- e. 5% Redtop Bentgrass / Agrostis Alba
  - f. Seeding rate: 1.5-2.5 lbs per 1,000 sq. ft.
- C. Grass-Seed Mix: Proprietary seed mix as follows:
- 1. Products: Subject to compliance with requirements, provide the following:
    - a. PT Lawn Seed: PT 755 Fleur De Lawn
    - b. Seed rate: 1-2 lbs per 1,000 sq. ft.

## 2.02 FERTILIZERS

- A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
- 1. Composition:
    - a. 16 percent nitrogen, 16 percent phosphorous, and 16 percent potassium, by weight.
    - b. Apply nitrogen at 6.5 lbs per 1,000 sq. ft.

## 2.03 MULCHES

- A. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors. Acceptable materials include:
- 1. Guar.
  - 2. Plantago/Psyllium.
  - 3. Starch.

## 2.04 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- 1. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
  - 2. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.
- B. Pesticide treatment plan to be developed based on observed weeds and County Weed Board BMPs, by an individual with a current pesticide applicator license.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 3. Uniformly moisten excessively dry soil that is not workable or that is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.02 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
  - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Manufactured Planting Soil:
- C. Prepare subgrade according to Section 329113 "Soil Preparation."
- D. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 4 inches of subgrade.
- E. Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
- F. Compact planting soil to 85 percent of maximum Standard Proctor density according to ASTM D698.

- G. Blending Planting Soil in Place:
- H. Prepare subgrade according to Section 329113 "Soil Preparation."
- I. Spread compost to total depth indicated on Drawings and fertilizer, if required, evenly on surface, and thoroughly blend into 6 inches of unamended, in-place soil to produce planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- J. Compact blended planting soil to 85 percent of maximum Standard Proctor density according to ASTM D698.
- K. Reduce elevation of planting soil to allow for soil thickness of sod roll, so top of soil after sod is placed is at finished grade. Maintain full required topsoil depth.
- L. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- M. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

#### 3.04 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial starter fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
  - 1. Mix slurry with tackifier.
  - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1,500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

#### 3.05 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod across slopes exceeding 1:3.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.06 **TURF MAINTENANCE**

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain irrigation system to keep turf uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
  2. Water turf at a minimum rate of 2 inches per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow to a uniform height between 3 and 4 inches.
- D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that provides actual nitrogen of at least 1 lb/1,000 sq. ft. or as recommended by fertilizer manufacturer, whichever is greater to turf area.

3.07 **SATISFACTORY TURF**

- A. Turf installations shall meet the following criteria as determined by Landscape Architect:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
  2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.



**3.08 PESTICIDE APPLICATION**

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

**3.09 CLEANUP**

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

**3.10 MAINTENANCE SERVICE**

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Schedule maintenance hand off and site review walk with facility maintenance staff for end of maintenance period. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
  - 1. Seeded Turf: one full growing season after seed has germinated, reached 2" height and is ready to be mown.
    - a. When initial maintenance period has not elapsed before end of growing season, or if turf is not fully established, continue maintenance during next planting season.
  - 2. Sodded Turf: one full growing season after installation.

\*\*\*END OF SECTION\*\*\*

**SECTION 32 93 00  
PLANTS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and Bid Documents of the Contract, including Division 01 Specification Sections, apply to this Section.
- B. ANSI A300 (Part 6) for Tree Care Operations – Tree, Shrub, and other Woody Plant Management: Standard Practices (Planting and Transplanting).

**1.02 SUMMARY**

- A. Section Includes:
  - 1. Plant materials.
  - 2. Fertilizers.
  - 3. Weed-control barriers.
  - 4. Mulches.
  - 5. Herbicides and pesticides.
  - 6. Tree-stabilization materials.
  - 7. Landscape edgings.
- B. Related Requirements:
  - 1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
  - 2. Section 328400 "Planting Irrigation" for complete irrigation systems.
  - 3. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

**1.03 DEFINITIONS**

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- J. Planting Area: Areas to be planted.
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.
- L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

#### 1.04 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.05 **PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

1.06 **SUBMITTALS**

- A. Product Data:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.

- B. Product Data Submittals: For each product.

1. Plant Materials: Include quantities, sizes, quality, and verified sources for plant materials.

- C. Samples for Verification: Actual sample of finished products for each of the following:

1. Organic Mulch: 1-quart volume of each organic mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.
2. Mineral Mulch: 2 lb of each mineral mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with source of mulch. Provide accurate indication of color, texture, and makeup.
3. Weed-Control Barrier: 12 by 12 inches.
4. Proprietary Root-Ball-Stabilization Device: One unit.
5. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
6. Root Barrier: Width of panel by 12 inches.

- D. Field Quality-Control Reports: Percolation tests for tree pits. Include the following:

1. Tree identification number matching the plans.
2. Date of test.
3. Time when water was added to tree pit to start percolation test.

4. Time with photo documentation showing increments of testing with water level in tree pit.
5. Identification of tester.
- E. Qualification Statements: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- F. Product Certificates: For each type of manufactured product, from manufacturer, and complying with manufacturer's certified analysis of standard products.
- G. Pesticides and Herbicides: Product label and manufacturer's written application instructions specific to Project.
- H. Sample Warranty: For special warranty.

**1.07 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.
- B. Maintenance Log: Provide record of all maintenance activities performed beginning at planting substantial completion through the end of the maintenance period.
- C. Delivery Invoices: Provide invoices showing quantities of plants delivered to the site.

**1.08 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
  1. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
  2. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
  3. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure in accordance with ANSI Z60.1. Do not prune to obtain required sizes.
  1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
  2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

- D. Plant Material Observation: Delivery invoices, showing quantities of plants delivered to the site.
- E. Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
  - 1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.
- F. Tree Planting Pre-installation Demonstration/Conference:
  - 1. Contractor shall schedule a tree planting demonstration and conference prior to the planting of any trees on site. The purpose of this conference is to demonstrate the Contractor's understanding of the tree planting drawings and specifications, and for the Landscape Architect to observe and approve the Contractor's tree planting practices on a minimum of three trees before remaining tree planting commences.
  - 2. Any personnel that will be involved with tree planting shall be present, including the landscape foreman.
  - 3. Contractor shall, in the presence of all required attendees, including the Landscape Architect, perform the work of planting the first three trees.
  - 4. If these tree planting mock-ups are approved on-site by the Landscape Architect as adhering to the drawings and specifications, and the trees are the correct species and in the correct locations per plans, they may remain in place for permanent installation.
  - 5. All subsequent tree planting that are not found to be in accordance with drawings and specifications will be rejected and replanted or replaced at the Contractor's expense.
  - 6. Please provide Landscape Architect with 2 weeks' notice in advance of Tree Planting Pre-Installation Demonstration/Conference.

**1.09 DELIVERY, STORAGE, AND HANDLING**

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, or walkways and pavements; or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.

- C. Deliver bare-root stock plants within 36 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- E. Handle planting stock by root ball.
- F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- H. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  - 1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
  - 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  - 3. Do not remove container-grown stock from containers before time of planting.
  - 4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.
- I. Retain a copy of all delivery invoices on-site. Provide Landscape Architect with invoices upon request.

#### 1.10 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant during one of the following period unless otherwise approved by Landscape Architect. Coordinate planting period with maintenance period to provide required maintenance from date of Substantial Completion.
  - 1. Planting: September 15<sup>th</sup>-May 30<sup>th</sup>.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions in accordance with manufacturer's written instructions and warranty requirements.

- D. Soil Conditions: Proceed with planting only when existing soil conditions permit planting to be performed when beneficial and optimum results may be obtained, unless approved by Landscape Architect. Do not plant during the following conditions unless approved.
1. When soil is saturated.
  2. When soil is frozen.

**1.11 WARRANTY**

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
1. Failures include, but are not limited to, the following:
    - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
    - b. Structural failures, including plantings falling or blowing over.
    - c. Faulty performance of tree stabilization, edgings, and tree grates.
    - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  2. Warranty Period: One year from date of Planting Substantial Completion
  3. Include the following remedial actions as a minimum:
    - a. Work with Landscape Architect to determine cause of plant failure and consider whether a different species or other corrections will be required to prevent additional failures.
    - b. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
    - c. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
    - d. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
    - e. Provide extended warranty for period equal to original warranty period, for replaced plant material.
- B. MAINTENANCE
1. See Section 32 05 33 – Landscape Establishment for plant establishment services.



PART 2 - PRODUCTS

2.01 PLANT MATERIALS

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
1. Trees with damaged, crooked, or multiple leaders; with tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); with crossing trunks; with cut-off limbs more than 3/4 inch diameter; or with stem girdling roots are unacceptable.
  2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare in accordance with ANSI Z60.1.
- D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for plant.
- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to ensure symmetry in planting.
- F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but are not yet in bloom.

2.02 FERTILIZERS

- A. Granular Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition:
    - a. 0.75 lb/1000 sq. ft. 3 percent of actual nitrogen, 4 percent phosphorous, and 3 percent potassium, by weight.
    - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition:
    - a. 20 percent nitrogen, 10 percent phosphorous, 10 percent potassium, by weight.

#### 2.03 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 6 oz./sq. yd. minimum, composed of fibers inert to biological degradation and naturally resistant to chemicals, alkalis, and acids, formed into a stable network so that fibers retain their relative position.

#### 2.04 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
  - 1. Type A: Arborist Mulch from an arborist chipping operation with less than 20% by volume green leaves. Chips stockpiled from the tree removal process may be used.
    - a. Size: 6 inch maximum, 1 inch minimum.
    - b. Color: Natural.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 6 to 8.5; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
  - 1. Organic Matter Content: 40 to 65 percent of dry weight.
  - 2. Feedstock: 100% recycled plant waste as defined in WAC 173-350 as "Wood waste", "Yard debris", "Post-consumer food waste", "Pre-consumer animal-based waste, and/or "Pre-consumer vegetative waste".
    - a. Feedstock Proportion: 80-90% yard waste, 10-20% post-consumer food waste.
    - b. Supplier shall provide list of feedstock sources by percentage in the final compost product.
- C. Mineral Mulch: Hard, durable stone, uniform in quality, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:
  - 1. Type B: River Rock
    - a. Size: 4 inch maximum, 1-1/2 inch minimum.
    - b. Color: Earth-tone colors. Submit for approval by Landscape Architect.

#### 2.05 HERBICIDES AND PESTICIDES

- A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

- C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

## 2.06 TREE-STABILIZATION MATERIALS

### A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or softwood with specified wood pressure preservative treatment, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Tree-Tie
  - a. Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
  - b. Chain-Lock: 1 inch width UV-resistant high-density polyethylene.

## 2.07 LANDSCAPE EDGINGS

### A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Edging Size: 1/4 inch thick by 5 inches deep, 0.1 inch thick by 4 inches deep.
2. Stakes: Tapered steel, a minimum of 12 inches long.
3. Accessories: Standard tapered ends, corners, and splicers.
4. Finish: Manufacturer's standard paint.
  - a. Paint Color: Black.

## 2.08 MISCELLANEOUS PRODUCTS

- A. Root Barrier: Black, molded, modular panels 18 inches high (deep), 85 mils thick, and with vertical root deflecting ribs protruding 3/4 inch out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix in accordance with manufacturer's written instructions.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
  1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
  3. Suspend planting operations during periods of excessive soil moisture until moisture content reaches acceptable levels to attain required results.
  4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove soil and contamination as directed by Landscape Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

### 3.03 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil in accordance with Section 329113 "Soil Preparation."
- B. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- C. Application of Mycorrhizal Fungi: At time directed by Landscape Architect, broadcast dry product uniformly over prepared soil at application rate in accordance with manufacturer's written instructions.

### 3.04 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
  2. Excavate approximately three times as wide as ball diameter for balled and burlapped, balled and potted, container-grown, or fabric bag-grown stock.
  3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
  4. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of root ball.

5. If area under the plant was initially dug too deep, add soil to raise it to correct level and thoroughly tamp the added soil to prevent settling.
  6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  7. Maintain supervision of excavations during working hours.
  8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to depth of 10 ft. (3 m), whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

### 3.05 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball in accordance with ANSI Z60.1. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare of 1 inch adjacent finish grades.
1. Backfill: Planting soil. For trees, use excavated soil for backfill.
  2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
    - a. Quantity: Two per plant.
  5. Continue backfilling process. Water again after placing and tamping final layer of soil.

- D. Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
1. Backfill: Planting soil. For trees, use excavated soil for backfill.
  2. Carefully remove root ball from container without damaging root ball or plant.
  3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
  5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
1. Backfill: Planting soil. For trees, use excavated soil for backfill.
  2. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
  5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- F. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare 1 inch above adjacent finish grade.
1. Backfill: Planting soil. For trees, use excavated soil for backfill.
  2. Spread roots without tangling or turning toward surface. Plumb before backfilling and maintain plumb while working.
  3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
  4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  5. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole or touching the roots.
  6. Continue backfilling process. Water again after placing and tamping final layer of soil.
- G. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

**3.06 MECHANIZED TREE-SPADE PLANTING**

- A. Plant trees with approved mechanized tree spade at designated locations. Do not use tree spade to move trees larger than maximum size allowed for similar field-grown, balled-and-burlapped, root-ball diameter in accordance with ANSI Z60.1, or trees larger than manufacturer's maximum size recommendation for tree spade being used, whichever is smaller.
- B. Use same tree spade to excavate the planting hole as will be used to extract and transport the tree.
- C. When extracting tree, center the trunk within the tree spade and move tree with solid ball of earth.
- D. Cut exposed roots cleanly during transplanting operations.
- E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.
- F. Where possible, orient the tree in same direction as in its original location.

**3.07 TREE, SHRUB, AND VINE PRUNING**

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Do not apply pruning paint to wounds.

**3.08 INSTALLATION OF TREE-STABILIZATION MATERIALS**

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
  - 1. Upright Staking and Tying:
    - a. Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend one-third of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
    - b. Stake trees with two stakes for trees up to 12 ft. high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 ft. high and up to 4 inches in caliper. Space stakes equally around trees.
  - 2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree. Leave at least 3 inches of space at loop around trunk to prevent girdling.

**3.09 INSTALLATION OF ROOT BARRIER**

- A. Install root barrier where trees are planted within 60 inches of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.
- B. Align root barrier vertically and run it linearly along and adjacent to paving or other hardscape elements to be protected from invasive roots.

- C. Install root barrier continuously for distance of 72 inches in each direction from tree trunk, for total distance of 12 ft. per tree. If trees are spaced closer, use single continuous piece of root barrier.
  - 1. Position top of root barrier 1/2 inch above finish grade of soil.
  - 2. Overlap root barrier minimum of 12 inches at joints.
  - 3. Do not distort or bend root barrier during construction activities.
  - 4. Do not install root barrier surrounding the root ball of tree.

### 3.10 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. Work soil around roots to eliminate air pockets and leave slight saucer indentation around plants to hold water.
- E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

### 3.11 INSTALLATION OF MULCHES

- A. Install weed-control barriers before placing mineral mulch in accordance with manufacturer's written instructions. Completely cover area to be mulched, overlapping edges minimum of 12 inches, and secure seams with galvanized pins.
- B. Mulch backfilled surfaces of planting areas and other areas indicated.
  - 1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not create a mulch cone or place mulch within 3 inches of trunks or stems.
  - 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

### 3.12 INSTALLATION OF LANDSCAPE EDGINGS

- A. Steel Edging: Install steel edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

### 3.13 APPLICATION OF HERBICIDES AND PESTICIDES

- A. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written instructions. Do not apply to seeded areas.



- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.
- C. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and in accordance with manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

**3.14 PLANT MAINTENANCE**

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- D. At end of maintenance period, pull all weeds, then top up mulch to 3-inch depth.
- E. Maintenance Period to end when warranty ends. At end of maintenance period, conduct a maintenance hand-off meeting on site with representative of ongoing maintenance team. Address any issues of non-compliance with this section to their satisfaction before hand-off.

**3.15 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  - 1. Perform tree pit percolation tests.
  - 2. Tree pit construction will be considered defective if it does not pass percolation tests and inspections.
  - 3. Do not proceed with planting in tree pits until satisfactory percolation is demonstrated.
- C. Prepare test and inspection reports.

**3.16 REPAIR AND REPLACEMENT**

- A. Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Landscape Architect.
  - 1. Submit details of proposed pruning and repairs.
  - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.

3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.
- B. Remove and replace trees that are more than 25 percent dead or in unhealthy condition before end of corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.
1. Provide new trees of same size as those being replaced for each tree of 6 inches or smaller in caliper size.
  2. Provide one new tree of 4-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.
  3. Species of Replacement Trees: Same species being replaced.

**3.17 CLEANING AND PROTECTION**

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

\*\*\*END OF SECTION\*\*\*

SECTION 41 22 13.13  
BRIDGE CRANES

**PART 1 - GENERAL**

- 1.1 Furnished by Contractor Installed by Contractor (FCIC)
  - A. Bridge Crane shall be Furnished by Contractor, Installed by Contractor (FCIC)
  
- 1.2 RELATED DOCUMENTS
  - A. Equipment items are listed below by Equipment I.D. Tag.
    - 1. Bridge Crane 5 Ton  
Equipment I.D. Tag: MB-07 [Qty: (1)]
  - B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  
- 1.3 SUMMARY
  - A. The work required under this section shall include the designing, manufacturing shipping, installation and field testing of a top running, single girder, overhead traveling bridge crane with one trolley hoist.
  - B. Related Section
    - 1. Structural Steel
    - 2. Special Coating
    - 3. Electrical Requirements
    - 4. Basic Electrical Materials and Methods
  
- 1.4 REFERENCES
  - A. Crane Manufacturers Association of America (CMAA)
    - 1. Specification No. 70 for Top Running & Under Running Single Girder Electric Overhead Traveling Cranes.
  - B. American National Standard (ANSI)
    - 1. ANSI B-30.16 Overhead Hoists
  - C. Occupational Safety and Health Administration (OSHA)
    - 1. Par. 1910.179 Overhead & Gantry Cranes
  - D. Hoist Manufacturers Institute (HMI)
  - E. National Electric Code (NEC)
    - 1. NEC (Latest Edition Article 610 Cranes and Hoists)
  - F. American Institute of Steel Construction (AISC)
    - 1. Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings
  - G. American Society for Testing and Materials (ASTM)
    - 1. A36/A36M - Specification for Carbon Structural Steel
  - H. American Welding Society (AWS)
  - I. D1.1 - Structural Welding Code - Steel
  - J. D14.1 - Overhead Cranes
  
- 1.5 SUBMITTALS
  - A. Shop Drawings and Equipment Data
    - 1. Submit for approval, Shop Drawings showing complete details and dimensions.
    - 2. Manufacturers catalog data.
    - 3. Wiring schematics – ship with crane
  - B. Operation and Maintenance Manuals
    - 1. Equipment function, normal operating characteristics, and limiting conditions.
    - 2. Assembly, installation, alignment, and maintenance instructions.
    - 3. Lubrication and maintenance instructions.

4. Guide to “troubleshooting”.
5. Parts list.
6. As-built drawing.
7. Test results.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturers shall have documented experience for ten (10) years, having successfully designed and built installations of similar scope.
- B. Manufacturer shall be responsible for providing equipment of highest quality and workmanship that will perform specific functions reliably and safely.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

#### 1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

#### 1.9 WARRANTY

- A. Comply with Division 01 Section “General Requirements”.
  1. “Maintenance services shall be provided by the Subcontractor at no additional cost to the Owner for one (1) year after final system acceptance. These services shall consist of manufacturer’s factory-trained representatives providing emergency repair service with on-site response within 24 hours of call, all test equipment and hardware necessary for maintenance and repair work and installation of any hardware modifications designed to improve system performance or eliminate known problems or deficiencies.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. All major components shall be provided by the Crane Vendor.
- B. Hoists, trolleys, bridge end trucks, drives and controls shall all be from one supplier and shall meet the requirements of this specification:

#### 2.2 CRANE SUMMARY

- A. Bridge Crane, Maintenance, Fleet Maintenance Bay (Qty 1) Equipment Tag #MB-07

Capacity:	5 Tons
Duty Class/Crane Classification:	CMAA Class C
Span:	25'-0”
Runway Length:	39'-6”
Hoist load:	10,000 lbs.
Number of Main hoists:	1
Hoist Group:	ASME H4
Hoisting height/Lift:	19'-8”
Trolley type:	Standard
Trolley traversing Speed:	65 ft/min stepless (variable frequency drive)
Hoist Speed:	20 / 3.2 ft/min two speed contactor control
Bridge Speed/Travelling Speed	100 ft/min stepless (variable frequency drive)
Environment:	Normal, indoor application.
Bumpers:	Rubber bumpers on end trucks and trolley per CMAA requirements.

Limit Switches

Hoist with geared upper and lower limit switch and block operated upper limit, overload limit switch set at 115% of full load. Trolley and bridge with travel limit switches.

2.3 RUNWAY ELECTRIFICATION

- A. The runway conductors shall be rolled galvanized steel bar comparable to Duct-o-wire Corporation. The minimum capacity of the conductor bar shall be sized to carry the necessary ampere load without undue heating.
- B. Four-conductor configuration shall be provided with all brackets, hangers, splice covers, power feeds, expansion gap assemblies and collectors as required by Conductix, Insul-8 or Duct-o-wire.

2.4 RUNWAY BEAMS and RAILS

- A. Runway supports, runway beams and end stops shall be supplied and installed by the metal building provider and are not included in this section.
- B. Rails shall be ASCE rails, sized according to the crane wheel loads and shall be supplied and installed by the crane manufacturer.
- C. The runway rails shall be attached to the runway beams using hook bolts, rail clips or clamps, as determined by the crane manufacturer.

2.5 EQUIPMENT

- A. Hoist and Trolley
  - 1. Top riding single girder crane shall utilize a low head room trolley hoist
  - 2. The hoist shall be equipped with an electro-mechanical load-limiting device that shall prevent lifting more than 115% of the rated load.
  - 3. Hoisting motor(s) shall be two-speed/two winding squirrel cage type with a speed ratio of 6:1.
  - 4. Hoisting motor(s) shall be totally enclosed with IP55 protection, minimum class F insulation, Klaxon type bimetal switch for thermal protection and shall have a 60% ED rating.
  - 5. Trolley shall be furnished with an adjustable frequency inverter drive and two-step or infinitely variable speed control for smooth acceleration and deceleration.
  - 6. Trolley motors shall be inverter duty motors with minimum class "F" insulation and motor enclosures shall be TENV [totally enclosed non-ventilated].
  - 7. Rotary cam type limit switch equipped with 4 micro-switches shall be provided. Limit switch shall provide upper and lower limit of hoist travel, hoist slow down prior to reaching upper limit and phase sequence supervision at upper limit.
  - 8. Hoist motor brake shall be DC disc type with adequate torque to stop and hold over 125% of the hoist rated load.
  - 9. Large diameter rope drum with minimum of 36:1 drum to wire rope diameter ration. Groove depth shall be at least 35% of rope diameter. The rope drum shall be equipped with a rope guide to help keep the rope aligned in the grooves of the drum.
  - 10. Wire rope shall be constructed from galvanized steel having a minimum safety factor of 5.
  - 11. Hoist reeving shall be single reeved. Lateral hook drift shall not exceed 1/8 inch per foot of vertical travel on single reeved models.
  - 12. The hoist nameplate is to carry a CSA US rating. The actual hoist control enclosure rating shall be at least equivalent to IP55 / NEMA 4 type.
  - 13. Hooks shall be made of forged alloy steel and shall be fitted with a spring-loaded flipper-type safety latch.
  - 14. Hoist shall have a duty rating suitable for the load class and load cycles of the application (reference appendix A).
  - 15. AGMA quality class 12 machine cut, hardened and precision ground hoist gearing. The gears inside the hoist gearboxes on models up to 5-ton capacity are lubricated by semi-fluid grease. On models over 5-ton capacity the gears inside the hoist gearbox are lubricated with semi-fluid grease or oil.
  - 16. AGMA quality class 10, hardened and precision ground trolley drive gearing, lubricated by semi-fluid grease.
  - 17. Trolleys shall have safety drop lugs and energy absorbing bumpers.
  - 18.

- B. Bridge Girder
  - 1. Bridge girders shall be constructed from welded box girders or Structural beams, Steel, ASTM A36, A50 or A992, as required.
- C. End Trucks and Bridge Drive
  - 1. End trucks shall be designed in accordance with CMAA specifications as applicable for the type crane.
  - 2. End trucks shall be bolted (not welded) to bridge girder.
  - 3. Bridge drive shall be dual motor (A-4 arrangement per CMAA)
  - 4. Bridge drive shall be designed to stop bridge within CMAA specifications.
  - 5. End trucks shall be equipped with rail sweeps and energy-absorbing rubber bumpers.
  - 6. Travel limit switches to be provided as necessary for safe operation.
  - 7. Bridge shall be furnished with an adjustable frequency inverter drive and two-step or infinitely variable speed control for smooth acceleration and deceleration.
  - 8. Bridge motors shall be inverter duty motors with minimum class "F" insulation and motor enclosures shall be TENV [totally enclosed non-ventilated].
  - 9. AGMA quality class 10, hardened and precision ground bridge drive gearing, lubricated by semi-fluid grease.
  - 10. Bridge girder shall be per 1.01B above, as applicable.
  - 11. Bridge girders shall be constructed from welded box girders or Structural beams, Steel, ASTM A36 A50 or A992, as required.
- D. Power Supply
  - 1. Power supply for the hoist shall be 480 Volt, 3 Phase, 60 Hz. All power required for the operation of the hoist, trolley, and end trucks shall be developed from this source.
  - 2. Runway electrification shall be 4-bar safety type rigid conductors comparable to Insul-8, Duct-O-Wire Company or Wampfler. Wall mounted disconnect switch and power to runway conductors provided by Electrical Contractor.
  - 3. Cross bridge electrification shall be flat cable style festoon system with terminal box, multi-conductor cord, plug connectors (when available) and accessories. Cables are to be hard-wired when plug connectors are not available.
- E. Controls
  - 1. Six-way operation, plug-in pushbutton pendant suspended from independent festoon track.
  - 2. Pendant shall include Start (momentary) button, Emergency Stop (push to maintain-turn to release) that controls a mainline contactor in the bridge panel.
  - 3. Pushbutton shall be clearly marked with hoist, trolley and bridge travel directions.
  - 4. Hoist shall be 2 speed magnetic reversing type (standard) or variable frequency inverter control (optional) and the trolley and bridge controls shall be variable frequency inverter control (standard).
  - 5. Electrical control enclosures shall be IP55 or NEMA 4 type. Pushbutton enclosure shall be non-corrosive, nonconductive and have a rating of IP65, NEMA 4X, 4 or 5.

### PART 3 - EXECUTION

- 3.1 INSTALLATION AND INSPECTION (If applicable to manufacturer)
  - A. Inspect structure and crane rail erection for conformance with reviewed shop drawings and contract documents prior to installation of equipment. Bring nonconforming work to the attention of the customer prior to proceeding with crane installation. Non-conforming runway structure or installation must be corrected prior to load testing of crane system. Costs of delays or additional work due to nonconforming runway structure will be reimbursed by the Owner.
  - B. Bridge crane shall be installed in conformance with manufacturer's instructions and inspected by a manufacturer's representative. Provide all necessary accessories to make bridge crane complete, usable, and capable of meeting the operating requirements specified in the Operating Requirements. Test, adjust and clean equipment for acceptance by Owner.
- 3.2 TESTING
  - A. All crane equipment shall be operated through a complete lift and lowering cycle and through a complete travel of the bridge and trolley to determine that the equipment shall perform smoothly

and safely and that pendant cable length is sufficient to permit operation from desired floor levels. All tests shall be carried out with the bridge crane equipment loaded at 100 percent of capacity, not to exceed 125 percent of capacity. The bridge crane provider shall provide the test weight loads. Any defects shall be corrected by the bridge crane provider without any expense to the Owner.

END OF SECTION

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