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# SECTION 210100 - BASIC FIRE PROTECTION REQUIREMENTS

## PART 1 - PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 21.

### 1.2 SUMMARY

A. The Fire Protection Contractor (F.C.) is defined as the Fire Protection contractor and his/her subcontractors and is responsible for all Fire Protection work as indicated on the plans.

B. Each contractor is responsible for reading and understanding this specification.

C. This Section includes general administrative and procedural requirements for fire protection installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:
1. Quality Assurance.
2. Submittals.
3. Drawings and Specifications.
4. Coordination Drawings.
5. Project Closeout.
6. Record Documents.
7. Maintenance Manuals.
8. Equipment and Systems Demonstration.
9. Delivery, Storage, and Handling.
10. Work Sequence.
11. Use of Premises.
12. Occupancy Requirements.
13. Inspections, Permits, Fees and Regulations.
14. Miscellaneous Provisions.
15. Workmanship.

D. Related Sections: The following sections contain requirements that relate to this section:

1. Division 21 Section "COMMON WORK RESULTS FOR FIRE PROTECTION," for materials and methods common to the remainder of Division 21, plus general related specifications including:

    a. Access to Fire Protection installations.
    b. Excavation for Fire Protection installations within the building boundaries, and from building to utilities connections.
    c. Structural steel work for Fire Protection installation.

### 1.3 QUALITY ASSURANCE

A. Equipment Selection: Equipment of greater or larger power, dimensions, weights, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting plumbing and electrical services, circuit breakers, conduit, motors, structural supports,bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

B. Product Uniformity: In order to provide the owner with systems that are reasonably maintainable, the contractor shall make product selections to assure manufacturer uniformity in all cases possible. This includes, but is not limited to, plumbing fixtures, sprinkler heads, valves, dampers, etc.

## 1.4 SUBMITTALS

A. General: Follow the procedures specified in Division 01.

B. Submittals are generally categorized as follows:

1. Test reports, inspections, and compliance data
2. Product data
3. Shop drawings
4. Technical supporting data and calculations
5. Maintenance, installation and trouble-shooting data
6. Guarantees and Warranties

C. Refer to each individual section for specific submittal requirements. Incomplete submittals will not be accepted.

D. The required Product Data submittals shall be forwarded as complete informational documents suitable to describe the performance characteristics of the product being submitted. In no case shall the content of these submittals be less informative than the products detailed/scheduled/specified within the contract documents. Incomplete product data submittals, as determined by the reviewing engineer, will be returned to the submitting contractor marked "incomplete", requiring the contractor/vendor to re-examine the specified requirements of the submittal.

E. Product data submittals comprising of manufactured equipment whose name does not appear within the specified "list" of acceptable manufacturers will not be approved for use unless "officially" added to the list prior to the actual bidding date. There will be no exceptions.

1. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.

    a. Do not proceed with installation until an applicable copy of Product Data applicable is in the installer's possession.
    b. Do not permit use of unmarked copies of Product Data in connection with construction.

2. Additional copies may be required by individual sections of these specifications.
3. Each copy is to be stamped approved by the contractor prior to submittal to the engineer.

## 1.5 DRAWINGS AND SPECIFICATIONS

A. Drawings indicate general arrangement of system and are to be followed insofar as possible. Deviations from drawings may be necessitated by field conditions. Detailed layouts of proposed departures to be submitted to Architect/Engineer for approval. Engineer written consent to change to be obtained before proceeding with work.

B. Drawings and Specifications to be considered cooperative and anything appearing in Specifications, but not on drawings, or vice versa, to be considered part of the Contract and to be executed.

C. Drawings indicate approximate location of various parts of work and are to be used as a general guide for installation. However, drawings are, to a considerable extent, diagrammatic and exact locations of piping, ductwork, etc., may appear on the drawings or must be worked out on job. Errors or omissions discovered by Bidding Contractors prior to bid openings, to be called to attention of Engineer/Project Manager without delay. Changes in plans or specifications resulting from such errors or omissions to be in effect only when corrected by Engineer by means of Addendum issued to all bidders prior to bid opening.

D. Comply with Architect's instructions for minor modifications in location of piping, ductwork, etc., to achieve effects desired by Architect.

E. If a specific item is specified or on drawings for multiple trades, this contractor shall include all items in the bid regardless of other trades. Resolution will be by Addendum or Change Order.

## 1.6 PROJECT CLOSEOUT

A. In order to achieve a complete and commissioned project, each contractor is responsible for the following items:

1. Building Inspection Certificates.
2. As-Built Drawings.
3. Final Payment Request.
4. Waiver of Liens.
5. Demonstration Certificates signed by Owner.
6. Delivery of extra materials.
7. Return of Borrowed Keys and Working Permits.
8. Letter Declaring Punch List Items Completed.
9. Operation and Maintenance Manuals.
10. Final Guarantee and Execution of Warranties.
11. Other requirements specified in Division 01 Specifications.

## 1.7 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 21 Section "Common Work Results for Fire Protection". Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

B. Record drawings must be kept by each contractor as up-to-date as-built drawings during the course of the project. Failure to display up-to-date as-builts on a monthly basis may result in partial payment requests being delayed/denied by the reviewing parties.

## 1.8 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for equipment items:

1. Complete information on project equipment and services as was submitted during the course of the project including an approved copy of each Product Data Submittal. This information is solely intended to provide the owner with accurate, usable information on how to care for his facility.
2. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
3. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
4. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassemble; aligning and adjusting instructions.
5. Servicing instructions and lubrication charts and schedules.
6. MSDS for each chemical compound used in mechanical systems.
7. A list of all equipment used on the project including Contractor’s purchase order numbers and suppliers name and address.

## 1.9 EQUIPMENT AND SYSTEMS DEMONSTRATION

A. Each contractor is responsible for verifying the complete operation of the equipment and systems installed as a part of the work. After the contractor is satisfied the work meets the specified intents and sequences of operation, the contractor shall schedule, through the Project Manager’s, a session during which all aspects of the work are explained to the Owner’s personnel and/or representatives.

B. This explanation session shall cover:

1. Items in the Maintenance Manuals.
2. Condition of the record drawings.
3. Location of equipment, both exposed and concealed.
4. Location of system control centers.
5. General overview of systems operation.
6. Items in need of specific attention.
7. Emergency shutdown procedures.

C. Factory-authorized demonstrations (during this session) are required from:

D. The general overview of systems operation shall include:

1. Fire Protection Maintenance Procedures.
2. Comments on system accessibility.
3. Special warrantees and procedures.

E. The intention of this specified item is for the Contractor to help the Owner understand the systems in the facility. Those present shall include:

1. Project Manager.
2. Project Superintendent.
3. Factory-authorized personnel from the manufacturers of equipment/systems noted above.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Comply with the guidelines and restrictions set forth in the pre-construction meeting.

1.11 WORK SEQUENCE

A. The Work will be conducted with coordination of all Trades to provide the least possible interference to the activities of the Owner's personnel and to permit an orderly transfer of personnel and equipment to the new facilities.

B. The Work will be conducted under supervision of the contractor with observation by the Engineer. The schedule of work will be determined by collaboration between the Contractor and the Project Manager.

C. The Work included in this project shall be terminated in a way which will allow future work to be continued in an advantageous manner. An advantageous manner shall be one which provides adequate access and the means by which existing work is easily extended.

D. Make connections to Fire Protection utilities and systems so as not to interfere with the Owner’s operations.

1.12 USE OF PREMISES

A. General: During the construction period the Contractor shall have full use of the premises for construction operations, including use of the project site. The Contractor's use of the premises is limited only by the Owner's right to perform work or to retain other contractors on portions of the project. Refer to supplemental conditions section of the specification for parking privilege information.

B. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the work is indicated.

1. Limits: Confine constructions operations to the Project Contract Limits.
2. Owner Occupancy: Allow for Owner occupancy of site.
3. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner’s employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances.
    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Removal of construction waste materials created by the methods employed by the Contractor(s) shall be the responsibility of the contractor(s). Dumping, burial, or burning of materials on the project site is not permitted.

## 1.13 INSPECTIONS, PERMITS, FEES AND REGULATIONS

A. Each contractor is responsible for submitting plans, paying fees, and organizing the required inspections to complete the Scope of Work. This includes, but is not limited to:

1. Building Department/Department of Commerce Inspections.
2. Boiler Inspections.
3. Pressure Piping Inspections.
4. Local Fire Department or Authority Inspection.
5. Owner's Risk/Loss Insurer Inspections.

B. All work and material to be accordance with all local, state and federal laws, ordinances, rules and regulations relating to work and latest edition of State and Local Mechanical Codes, including amendments. Where drawings or specifications exceed legal requirements, the design shall govern. However, no work to be installed contrary to or below minimum legal standards.

## 1.14 MISCELLANEOUS PROVISIONS

A. Field Conditions: Since the Contract Documents do not contain full size scaled plans, the Contractor is responsible for reviewing and understanding all existing field conditions to perform the work described in these specifications. The Contractor shall refer to the schematics provided within the specifications, investigate the existing field conditions to the fullest extent possible, and provide all work as required for a full and complete installation, adhering to the scope of work and sequences within the Contractor Documents.

B. The Fire Protection Contractor shall locate and inspect each item referenced as being part of existing building systems. Upon inspection, the Contractor is to verify that each intended integration of new system to old system can be accomplished. Any discrepancies or unforeseen incompatibilities must be notified prior to bid acceptance.

1. These items include, but are not limited to: sprinkler lines and shutoff valves, sprinkler heads.

# PART 2 - PRODUCTS

## 2.1 GENERAL

A. Not Applicable.

# PART 3 - EXECUTION

## 3.1 WORKMANSHIP

A. All work shall be performed by workers skilled in the particular trade involved and shall be done in a neat, workmanlike manner, up to present standards and practices.

B. Unless specified otherwise, all materials shall be new and both workmanship and materials shall be of good quality.

C. The Contractor shall have in charge of the work at all times during construction a competent foreman or superintendent, experienced in the work to be installed under this division of the work and with previous experience as a foreman for the Contractor.

D. Provide Owner training for all portions of system.

END OF SECTION 220100

# SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Supports and anchorages.
10. Cutting and Patching.
11. Seismic design requirements

### 1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

F. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Escutcheons.
4. Expansion fittings.

B. Welding certificates.

C. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

D. Coordination Drawings: For access panel and door locations.

E. It is this contractor's responsibility to provide a design build, pre-engineered seismic design and construction package for this project's systems in compliance with all applicable codes for this jurisdiction. The firm engaged to provide engineering and materials shall have a minimum of 5 years of experience and satisfactory use of their products. Provide complete design calculations package signed and stamped by a professional engineer experienced in seismic restraint design. Provide a complete submittal package for building and fire department review.

F. Seismic Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Include design calculations and details for selecting vibration isolators, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, forces required to select vibration isolators and for designing vibration isolation bases.
   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
3. 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 the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
   d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction showing maximum ratings of restraint items and the basis for approval (tests or calculations).

G. Coordination Drawings: Detail major elements, components, and systems of equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement.
2. Clearances for installing and maintaining insulation.

3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
4. Equipment and accessory service connections and support details.
5. Exterior wall and foundation penetrations.
6. Fire-rated wall and floor penetrations.
7. Sizes and location of required concrete pads and bases.
8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

## 1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Equipment: Equipment of different electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Additional costs must be approved in advance by appropriate contract modification for these increases. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

E. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## 1.6 WARRANTIES

A. Provide a one (1) year warranty for all systems including equipment, materials, parts and labor. Equipment manufacturer warranties shall benefit and inure to Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.8 COORDINATION

A. Review with General Trades Contractor for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate with General Trades Contractor installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate with General Trades Contractor requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

1.9 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Design to be based on 110 MPH Ult. Design wind speed..

B. Seismic-Restraint Loading:

1. Site Class: B. Design Category: B.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: II.

a. Component Importance Factor: 1.0

3. Seismic response coefficient: Cs = 0.037.
4. Refer to structural drawings for more seismic information.

1.10

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.

g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psi minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.

c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.
c. Epco Sales, Inc.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.

## 2.5 FIRE BARRIER SEALANT MATERIALS

A. Provide U.L. classified systems that meet or exceed indicated fire ratings.

1. Manufacturers:

a. Flame-Safe FS900/FST900 Series, International Protective Coatings Corp.
b. Metacaulk 950, The RectorSeal Corporation.
c. Fire Barrier CP 25WB Caulk, 3M Fire Protection Products.
d. Pensil 500 Intumescent Putty, General Electric Co.
e. Flame-Safe FSP1000 Putty, International Protective Coatings Corp.
f. Fire Barrier Moldable Putty, 3M Fire Protection Products.
g. Dow Corning Firestop Sealant SL 2003, Dow Corning Corp.
h. Pensil 100 Firestop Sealant, General Electric Co.
i. Matacaulk 880, The RectorSeal Corporation.
j. Fyre-Sil S/L, Tremco Inc.
k. Dow Corning Firestop Foam 2001, Dow Corning Corp.

l. Pensil 200 Foam, General Electric Co.

## 2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.

D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

E. PVC Pipe: ASTM D 1785, Schedule 40.

## 2.7 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

# PART 3 - EXECUTION

3.1 FIRE PROTECTION INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of fire protection systems, materials, and equipment. Comply with the following requirements:

1. Coordinate piping, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Contractor is responsible for installation of electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

    a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to manufacturer and equipment installer.

8. Coordinate connection of systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
9. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Associate.
10. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
11. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
12. Contractor is responsible for installation of access panels or doors where items requiring access are concealed behind finished surfaces. Access panels and doors shall be equal to those specified in General Sections.
13. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
14. Install systems to conform with the declared intent of performance. Do not install systems, or components of systems, that are knowingly inconsistent with the declared intent of performance. Refer all perceived discrepancies to the Associate prior to the preparation of installation materials.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections. Make piping connections avoiding the use of tee fittings in the “bullhead” position.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

L. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
    b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

        1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Firestopping materials are specified in Division 21.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

## 3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

## 3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

## 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect.

## 3.6 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

## 3.7 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

D. Equipment Restraints:

1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
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 an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in MSS SP-127.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

I. 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.

J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

K. 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 structural engineer 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, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the 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 the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

## 3.8 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 221116 "Domestic Water Piping" for piping flexible connections.

## 3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel. This contractor is responsible for work as defined below.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

END OF SECTION 210500

# SECTION 210533 - HEAT TRACING FOR FIRE-SUPPRESSION PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes heat tracing for fire-suppression piping with self-regulating parallel resistance electric heating cables with monitored controller. System to be in conformance with NFPA 25 and all UL requirements.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, monitoring, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

### 1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

## 2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers:

1. Raychem, Tyco Thermal Controls.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.2 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

E. Provide monitoring  system with required alarms and /or interlocks per NFPA requirements.

## 2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer or as recommended in writing by manufacturer.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable where indicated and according to NFPA 70 and NFPA 13.

B. Install electric heating cable across expansion joints according to manufacturer's written instructions; use cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables according to IEEE 515.1.

E. Install insulation over piping with electric cables according to Section 210700 "Fire-Suppression Systems Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect heat-tracing controls to fire-alarm system according to NFPA 13. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Test monitoring and alarm systems.

G. Prepare test and inspection reports.

## 3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 210533

# SECTION 211313 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:
   1. Wet-pipe sprinkler systems.

B. Related Sections include the following:

   1. Division 22 Section "Facility Water Distribution Piping" for piping outside the building.
   2. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

### 1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. CPVC: Chlorinated polyvinyl chloride plastic.

C. PE: Polyethylene plastic.

D. Underground Service-Entrance Piping: Underground service piping below the building.

### 1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if required.

### 1.5 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

   1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

2. Maximum Protection Area per Sprinkler: Per FM and UL listing.

1.6 SUBMITTALS

A. Product Data: For the following:

1. Piping materials and sprinkler specialty fittings.
2. Pipe hangers and supports.
3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
5. Fire department connections. Include type of fire department connection; number, size, type, and arrangement of inlets; size and direction of outlet; and finish.
6. Alarm devices, including electrical data.

B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.

C. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

D. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

E. Fire-pump flow test report.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

1.8 COORDINATION

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

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795,with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
4. Steel Threaded Couplings: ASTM A 865.

B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Ductilic, Inc.

3) JDH Pacific, Inc.
4) National Fittings, Inc.
5) Shurjoint Piping Products, Inc.
6) Southwestern Pipe, Inc.
7) Star Pipe Products; Star Fittings Div.
8) Victaulic Co. of America.
9) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves,rubber gasket listed for use with housing, and steel bolts and nuts.

D. Plain-End, Schedule 30 Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30; or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

E. Grooved-End, Schedule 30 Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30; or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe; with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Ductilic, Inc.
3) JDH Pacific, Inc.
4) National Fittings, Inc.
5) Shurjoint Piping Products, Inc.
6) Southwestern Pipe, Inc.
7) Star Pipe Products; Star Fittings Div.
8) Victaulic Co. of America.
9) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

## 2.3 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.

B. Outlet Specialty Fittings:

1. Manufacturers:

a. Anvil International, Inc.
b. Ductilic, Inc.
c. JDH Pacific, Inc.
d. National Fittings, Inc.
e. Shurjoint Piping Products, Inc.
f. Southwestern Pipe, Inc.
g. Star Pipe Products; Star Fittings Div.
h. Victaulic Co. of America.
i. Ward Manufacturing.

2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:

a. Fire-End and Croker Corp.
b. Viking Corp.
c. Victaulic Co. of America.

D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Manufacturers:

a. Elkhart Brass Mfg. Co., Inc.
b. Fire-End and Croker Corp.
c. Potter-Roemer; Fire-Protection Div.

E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Manufacturers:

a. AGF Manufacturing Co.
b. Central Sprinkler Corp.
c. G/J Innovations, Inc.
d. Triple R Specialty of Ajax, Inc.

F. Flexible, Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
a. Fivalco Inc.
b. FlexHead Industries, Inc.
c. Gateway Tubing, Inc.
d. <Insert manufacturer's name>.

2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175 psig minimum.

## 2.4 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
3. Manufacturers:

    a. Grinnell Fire Protection.
    b. McWane, Inc.; Kennedy Valve Div.
    c. NIBCO.
    d. Stockham.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3: Ductile-iron body with grooved ends.
4. Manufacturers:

    a. NIBCO.
    b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.

    a. Manufacturers:

        1) Global Safety Products, Inc.
        2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

    a. Manufacturers:

        1) Global Safety Products, Inc.
        2) McWane, Inc.; Kennedy Valve Div.
        3) Mueller Company.
        4) NIBCO.
        5) Pratt, Henry Company.
        6) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:

a. Clow Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Firematic Sprinkler Devices, Inc.
e. Globe Fire Sprinkler Corporation.
f. Grinnell Fire Protection.
g. Hammond Valve.
h. McWane, Inc.; Kennedy Valve Div.
i. Mueller Company.
j. NIBCO.
k. Potter-Roemer; Fire Protection Div.
l. Reliable Automatic Sprinkler Co., Inc.
m. Star Sprinkler Inc.
n. Stockham.
o. Victaulic Co. of America.
p. Watts Industries, Inc.; Water Products Div.

F. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.
4) United Brass Works, Inc.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

a. Manufacturers:

1) Clow Valve Co.
2) Crane Co.; Crane Valve Group; Crane Valves.
3) Crane Co.; Crane Valve Group; Jenkins Valves.
4) Hammond Valve.
5) Milwaukee Valve Company.
6) Mueller Company.
7) NIBCO.
8) Red-White Valve Corp.

## 2.5 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating.

1. Manufacturers:

a. Firematic Sprinkler Devices, Inc.
b. Globe Fire Sprinkler Corporation.
c. Grinnell Fire Protection.
d. Reliable Automatic Sprinkler Co., Inc.
e. Star Sprinkler Inc.
f. Tyco Fire Suppression Systems.
g. Victaulic Co. of America.
h. Viking Corp.

2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

a. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

1. Manufacturers:

a. AFAC Inc.
b. Grinnell Fire Protection.

## 2.6 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Manufacturers:

1. Firematic Sprinkler Devices, Inc.
2. Globe Fire Sprinkler Corporation.
3. Grinnell Fire Protection.
4. Reliable Automatic Sprinkler Co., Inc.
5. Star Sprinkler Inc.
6. Tyco Fire Suppression Systems.
7. Victaulic Co. of America.
8. Viking Corp.

C. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 199, for nonresidential applications.
2. UL 1767, for early-suppression, fast-response applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

E. Sprinkler Finishes: Chrome plated and bronze.

F. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.7 FIRE DEPARTMENT CONNECTIONS

A. Provide and install fire department connections per local jurisdictional requirements.

1. Install protective pipe bollards at each fire-department connection.

2.8 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:

a. ADT Security Services, Inc.
b. Grinnell Fire Protection.
c. ITT McDonnell & Miller.
d. Potter Electric Signal Company.
e. System Sensor.
f. Viking Corp.
g. Watts Industries, Inc.; Water Products Div.

C. Electrically Operated Alarm Bell:

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

a. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Notifier; a Honeywell company.
c. Potter Electric Signal Company.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.

2.9 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge.
2. Brecco Corporation.
3. Dresser Equipment Group; Instrument Div.
4. Marsh Bellofram.
5. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig.

## 2.10 BACKFLOW PREVENTERS

A. Double-Check, Backflow-Prevention Assemblies:

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

   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Wilkins Water Control Products Division.
   g. Apollo Valves.

2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle one-third of flow range.
5. Body Material: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved, steel with interior lining complying with AWWA C550 or that is FDA approved, stainless steel for NPS 2-1/2 and larger.
6. End Connections: Flanged.
7. Accessories: OS&Y gate valves with flanged ends on inlet and outlet.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14,and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

## 3.2 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING APPLICATIONS, GENERAL

A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

B. Underground Service-Entrance Piping: Refer to Site Civil plans and specifications for underground service piping requirements.

C. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:

1. Sprinkler-Piping Fitting Option: Specialty sprinkler fittings, NPS 2 and smaller, including mechanical-T and -cross fittings, may be used.
2. NPS 1-1/2 and Smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
3. NPS 2: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
4. NPS 2: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
5. NPS 2: Grooved-end, black, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
6. NPS 2: Threaded-end, black, Schedule 30 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
7. NPS 2: Plain-end, black, Schedule 30 steel pipe; steel welding fittings; and welded joints.
8. NPS 2: Grooved-end, black, Schedule 30 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
9. NPS 2-1/2 to NPS 8: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
10. NPS 2-1/2 to NPS 8: Grooved-end, black, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
11. NPS 2-1/2 to NPS 8: Plain-end, black, Schedule 30 steel pipe; steel welding fittings; and welded joints.

12. NPS 2-1/2 to NPS 8: Grooved-end, Schedule 30 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

## 3.6 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13.

a. Shutoff Duty: Use ball, butterfly, or gate valves.

## 3.7 JOINT CONSTRUCTION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.

B. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

C. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

D. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

## 3.8 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 21 Section "Facility Fire Suppression Water-Service Piping" for exterior piping.

B. Retain and edit paragraph above or below. Backflow preventers are recommended and usually required by authorities having jurisdiction.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

## 3.9 PIPING INSTALLATION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Install underground service-entrance piping according to NFPA 24 and with restrained joints.

D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

J. Install alarm devices in piping systems.

K. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install sprinkler system piping according to NFPA 13.

L. Install pressure gages on riser. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Fill wet-pipe sprinkler system piping with water.

## 3.10 VALVE INSTALLATION

A. Install listed fire-protection valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply. Install permanent identification signs indicating portion of system controlled by each valve.

C. Specialty Valves:

1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.11 SPRINKLER APPLICATIONS

A. Refer to Sprinkler Head Schedule on Construction Documents for head types and locations.

3.12 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.13 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect piping to specialty valves, specialties, fire department connections, and accessories.

D. Connect alarm devices to fire alarm.

3.14 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.15 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire alarm tests. Operate as required.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.16 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

3.17 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 211000

# SECTION 211316 - DRY-PIPE SPRINKLER SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinkler specialty pipe fittings.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

### 1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For dry-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For dry-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

### 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale.

B. Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.

C. Qualification Data: For qualified Installer and professional engineer.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

E. Fire-pump flow test report.

F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

G. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dry-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

## 1.9 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Construction Manager's] Owner's written permission.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Available fire-hydrant flow test records indicate the following conditions:

a. Flow test information is available on drawings.

D. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: **10** percent, including losses through water-service piping, valves, and backflow preventers.

### 2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Pipe ends may be factory or field formed to match joining method. Thin wall piping is not permitted.

B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

C. Galvanized-Steel Couplings: ASTM A 865/A 865M, threaded.

D. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Malleable- or Ductile-Iron Unions: UL 860.

F. Cast-Iron Flanges: ASME B16.1, Class 125.

G. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.

H. Grooved-Joint, Steel-Pipe Appurtenances:
1. Pressure Rating: **175-psig (1200-kPa)** minimum.
2. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.

3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

## 2.3 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Dry-Pipe Valves:
1. Standard: UL 260.
2. Design: Differential-pressure type.
3. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
4. Air-Pressure Maintenance Device:
5. Standard: UL 260.
6. Type: Automatic device to maintain minimum air pressure in piping.
7. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) outlet pressure.
8. Air Compressor:
   a. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
   b. Motor Horsepower: Fractional.
   c. Power: 120-V ac, 60 Hz, single phase.

G. Automatic (Ball Drip) Drain Valves:
1. Standard: UL 1726.
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 (DN 20).
5. End Connections: Threaded.

## 2.4 SPRINKLER PIPING SPECIALTIES

A. General Requirements for Dry-Pipe System Fittings: UL listed for dry-pipe service.

B. Branch Outlet Fittings:
1. Standard: UL 213.
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.

4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

C. Flow Detection and Test Assemblies:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
3. Size: Same as connected piping.
4. Inlet and Outlet: Threaded.

D. Branch Line Testers:
1. Standard: UL 199.
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

E. Sprinkler Inspector's Test Fittings:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Body Material: Cast- or ductile-iron housing with sight glass.
3. Size: Same as connected piping.
4. Inlet and Outlet: Threaded.

F. Adjustable Drop Nipples:
1. Standard: UL 1474.
2. Body Material: Steel pipe with EPDM O-ring seals.
3. Size: Same as connected piping.
4. Length: Adjustable.
5. Inlet and Outlet: Threaded.

G. Flexible Sprinkler Hose Fittings:
1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Size: Same as connected piping, for sprinkler.

## 2.5 SPRINKLERS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

C. Sprinkler Finishes: Chrome plated.

D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

## 2.6 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:
   1. Standard: UL 464.
   2. Type: Vibrating, metal alarm bell.
   3. Size: 8-inch minimum diameter.
   4. Finish: Red-enamel factory finish, suitable for outdoor use.
   5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Pressure Switches:
   1. Standard: UL 346.
   2. Type: Electrically supervised water-flow switch with retard feature.
   3. Components: Single-pole, double-throw switch with normally closed contacts.
   4. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches:
   1. Standard: UL 346.
   2. Type: Electrically supervised.
   3. Components: Single-pole, double-throw switch with normally closed contacts.
   4. Design: Signals that controlled valve is in other than fully open position.
   5. 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

## 2.7 MANUAL CONTROL STATIONS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.

B. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## 2.8 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.

   1. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
   2. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
   3. 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. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

C. Panels Components:

1. Power supply.
2. Battery charger.
3. Standby batteries.
4. Field-wiring terminal strip.
5. Electrically supervised solenoid valves and polarized fire-alarm bell.
6. Lamp test facility.
7. Single-pole, double-throw auxiliary alarm contacts.
8. Rectifier.

## 2.9 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gage Range: 0- to 250-psig minimum.

D. Label: Include "WATER" or "AIR/WATER" label on dial face.

E. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

# PART 3 - EXECUTION

## 3.1 PREPARATION

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

B. Report test results promptly and in writing.

## 3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or to outside building.

I. Install alarm devices in piping systems.

J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13.

K. Install pressure gages on riser or feed main, at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

L. Drain dry-pipe sprinkler piping.

M. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

## 3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

## 3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

## 3.5 SPRINKLER INSTALLATION

A. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

B. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

## 3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

## 3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

## 3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

END OF SECTION 211316

# SECTION 213116 DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes diesel-drive, split-case centrifugal fire pumps and the following:

1. Fire-pump controllers.
2. Fire-pump accessories and specialties.
3. Pressure-maintenance pumps, controllers, accessories, and specialties.
4. Alarm panels.

### 1.3 PERFORMANCE REQUIREMENTS

A. Pump, Equipment, Accessory, Specialty, and Piping Pressure Rating: 175-psig (1200-kPa) minimum working-pressure rating, unless otherwise indicated.

### 1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, certified pump performance curves with each selection point indicated, operating characteristics, and furnished accessories and specialties for each fire pump and pressure-maintenance pump.

B. Shop Drawings: For fire pumps and drivers, fire-pump controllers, fire-pump accessories and specialties, pressure-maintenance pumps, pressure-maintenance-pump controllers, and pressure-maintenance-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Product Certificates: For each type of fire pump and fire-pump controller, signed by product manufacturer.

D. Source quality-control test reports with certified shop test curves.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For fire pumps and drivers, pressure-maintenance pumps, controllers, accessories and specialties, alarm panels, and flowmeter systems to include in emergency, operation, and maintenance manuals.

### 1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fire pumps, pressure-maintenance pumps, and controllers through one source from a single manufacturer for each type of equipment.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of fire pumps, pressure-maintenance pumps, and controllers and are based on specific systems indicated. Refer to Division 1 Section "Product Requirements."

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

D. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.

E. Comply with NFPA 20, "Stationary Pumps for Fire Protection," for fire pumps, drivers, controllers, accessories, and their installation.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 CENTRIFUGAL FIRE PUMPS

A. Description, General: UL 448, factory-assembled and -tested, diesel-drive, centrifugal fire pumps capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head.

1. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
2. Nameplate: Complete with capacities, characteristics, and other pertinent data.

B. Fabricate base and attachment to fire pumps, pressure-maintenance pumps, and controllers with reinforcement to resist movement of pumps and controllers during a seismic event when their bases are anchored to building structure.

C. Single-Stage, Horizontally Mounted, Split-Case Fire Pumps: Double-suction type with pump and driver mounted on same base and connected with coupling.

1. Manufacturers:
   a. Aurora Pump; Pentair Pump Group.
   b. Fairbanks Morse; Pentair Pump Group.
   c. Sterling Peerless Pump; Sterling Fluid Systems Group (Base Design).

2. Pump: Axially split cast-iron casing with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless otherwise indicated.

    a. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
    b. Wear Rings: Replaceable, bronze.
    c. Shaft and Sleeve: Steel shaft with bronze sleeve.

        1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
        2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

3. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
4. Driver: UL 1247, horizontal-shaft, diesel engine.

    a. Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.

        1) Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8, BCuP Series brazing filler metal; and brazed joints.

    b. Engine-Jacket Water Heater: Factory-installed electric elements.
    c. Dual Batteries: Lead-acid-storage type, with 100 percent standby reserve capacity.
    d. Fuel System: According to NFPA 20.

        1) Fuel Storage Tank: Size indicated, but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.

        2) Fuel tank shall be 250 gallons or as required to maintain pump operation of sufficient duration to meet NFPA and local jurisdictional requirements with the following options: Double wall construction, manual fill with containment and lockable manual fill cap, normal vent cap with insect screen, (2) 4” emergency vent caps (for relief of pressure only), 1” lockable drain valve, overflow basin, overflow alarm and leak switch.

    e. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.

        1) Exhaust Connector: Flexible type.
        2) Exhaust Silencer: Industrial type.

## 2.3 FIRE-PUMP CONTROLLERS

A. Description: UL 218 and NFPA 20, listed for diesel-drive, fire-pump service; combined automatic and manual operation; factory assembled and wired; and factory tested for capacities and electrical characteristics.

1. Manufacturers:

    a. Joslyn Clark.
    b. Master Control Systems, Inc. (Base design)
    c. Metron, Inc.

2. Enclosure: UL 50, NEMA 12, drip proof, indoor, unless special-purpose enclosure is indicated. Include manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.

    a. Mounting: Base mounted and wired at factory.

3. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed.
4. Battery Charge UL 1236, built-in, dual-battery type.

    a. Manufacturers:

        1) La Marche Manufacturing Company.
        2) Master Control Systems, Inc.
        3) Metron, Inc.

    b. Time clock for weekly automatic test.
    c. System pressure recorder, electric ac driven with spring backup.
    d. Timing relay for automatic stop.
    e. Fire alarm system starting contact input.
    f. Low-fuel-level alarm.
    g. Alarm contacts for remote alarm of "Engine Run," "Switch Off," "Engine Failure" and “Pump House Trouble” to Fire Alarm System.
    h. Pump room alarms, including both audible and visible signals.

5. Underwriters Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.
6. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous-metal sensing piping, NPS 1/2 (DN 15), with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32-inch (2.4-mm) orifice in clapper or ground-face union with noncorrosive diaphragm having 3/32-inch (2.4-mm) orifice.

## 2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:

1. Automatic air-release valve.
2. Suction and discharge pressure gages.
3. Eccentric-tapered reducer at suction inlet.
4. Concentric-tapered reducer at discharge outlet.
5. Test-Header Manifold: Ductile-iron or brass body for hose valves. Include nozzle outlets arranged in single line; horizontal, flush-wall mounting attachment; and rectangular, brass finish escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
6. Test-Header Manifold: Ferrous body for hose valves. Manufacturer's standard finish. Include bronze or cast-iron, exposed-type valve header with nozzle outlets; and round, brass escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
7. Hose Valves: UL 668, straightway pattern, and bronze with cap and chain. Include NFPA 1963 hose thread that complies with local fire department standards and finish same as for test-header-manifold escutcheon plate.
8. Ball Drip Valve: UL 1726.
9. Main Relief Valve: UL 1478, pilot operated.
10. Finish: Manufacturer's standard factory-applied red paint unless brass or other finish is specified.

## 2.5 PRESSURE-MAINTENANCE PUMPS

A. "Pressure-Maintenance Pumps, General: Factory-assembled and -tested pumps with electric-motor driver, controller, and accessories and specialties. Include cast-iron or stainless-steel casing and bronze or stainless-steel impellers, mechanical seals, and suction and discharge flanges machined to ASME B16.1, Class 125 dimensions unless Class 250 flanges are indicated and except that connections may be threaded in sizes where flanges are not available.

1. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.
2. Nameplate: Complete with capacity, characteristics, and other pertinent data.

B. Centrifugal, Pressure-Maintenance Pumps: Close-coupled type complying with HI 1.1-1.2 and HI 1.3 requirements for centrifugal pumps. Include base.

1. Manufacturers:

a. Aurora Pump; Pentair Pump Group.
b. Fairbanks Morse; Pentair Pump Group.
c. Peerless Co.
d. Weber Industries (Base design).

2. Driver: NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.

C. Controllers: UL 508; factory-assembled, -wired, and -tested, across-the-line type for combined automatic and manual operation.

1. Manufacturers:

a. Joslyn Clark.
b. Master Control Systems, Inc. (Base design).
c. Metron, Inc.

2. Enclosure: UL 508 and NEMA 250, Type 2, wall-mounting type for field electrical wiring.

a. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.

3. Rate controller for scheduled horsepower and include the following:

a. Fusible disconnect switch.
b. Pressure switch.
c. Hand-off-auto selector switch.
d. Pilot light.
e. Running period timer.

D. Accessories and Specialties: Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:

1. Suction and discharge pressure gages.

## 2.6 ALARM PANELS

A. Description: Factory-assembled and -wired remote panel complying with UL 508 and requirements in NFPA 20. Include audible and visible alarms matching controller type.

1. Manufacturers:

a. Joslyn Clark.
b. Master Control Systems, Inc.
c. Metron, Inc.

2. Enclosure: NEMA 250, Type 2, remote wall-mounting type.

a. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.

3. Features: Include manufacturer's standard features and the following:

a. Motor-operating condition.
b. Loss-of-line power.
c. Low-water alarm.

## 2.7 PRESSURE GAGES

A. Description: UL 393, 3-1/2- to 4-1/2-inch- (90- to 115-mm-) diameter dial with range of 0- to 300-psig (0- to 2070-kPa) minimum. Include caption "WATER" on dial face.

1. Manufacturers:

a. AGF Manufacturing Co.
b. AMETEK, Inc.; U.S. Gauge.
c. Brecco Corporation.
d. Dresser Equipment Group; Instruments Div.
e. Marsh Bellofram.
f. WIKA Instrument Corporation.

## 2.8 GROUT

A. Description: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

## 2.9 SOURCE QUALITY CONTROL

A. Test and inspect fire pumps with their controllers according to NFPA 20 for certified shop tests.

B. Verification of Performance: Rate fire pumps according to requirements indicated.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas, concrete bases, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping to verify actual locations of piping connections before fire-pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for fire pumps, pressure-maintenance pumps, and controllers. Refer to Division 15 Section "Basic Mechanical Materials and Methods."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

## 3.3 INSTALLATION

A. Install and align fire pump, pressure-maintenance pump, and controller according to NFPA 20.

B. Install pumps and controllers to provide access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Set base-mounting-type pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

1. Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near anchor bolts, to provide 3/4- to 1-1/2-inch (19- to 38-mm) gap between pump base and concrete base for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Verify that coupling faces and pump suction and discharge flanges are level and plumb.
3. Pump representative shall check and verify that alignment is correct.

D. Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles.

E. Install valves that are same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.

F. Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.

G. Support pumps and piping separately so weight of piping does not rest on pumps.

H. Install fuel system according to NFPA 20.

I. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.

J. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation and joint construction.

K. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.

L. Install exhaust system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints, and components having flanged connections with gasketed joints.

M. Install condensate drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.

N. Install PVC drain line from fire pump packing seal to nearest floor drain.

O. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

P. Fuel Tank Installation:

1. 4” vent, shall be raised approximately 10’ above the tank.
2. Fuel supply and overflow lines shall be 5/8” O.D., steel black pipe.
3. Outlet must be even with engine fuel pump centerline.
4. Should be located as close to engine as possible and pitched ¼”/ft. toward drain plug.
5. Install Morrison #518 spill container for the fuel tank fill.

## 3.4 ALIGNMENT

A. Align fire-pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

E. Above shall be checked by pump manufacturing representative.

## 3.5 CONNECTIONS

A. Piping installation requirements are specified in Division 13 Section "Fire-Suppression Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to point of disposal.

D. Connect cooling-system water drain piping to diesel engine heat exchangers.

E. Connect drain from pump packing seal to nearest floor drain, use PVC pipe material or vynal tube.

F. Connect exhaust system piping to diesel engines.

G. Connect controllers to system.

H. Connect fire-pump controllers to building fire-alarm system. Refer to Division 13 Section "Fire Alarm."

I. Ground equipment according to Division 16 Section "Grounding and Bonding."

J. Connect wiring according to Division 16 Section "Conductors and Cables."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire pump performs as indicated.

C. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:

    a. Lubricate oil-lubrication-type bearings.
    b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
    c. 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.

3. Starting procedure for pumps is as follows:

    a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.
    b. Open sealing-liquid supply valves if pump is so fitted.
    c. Start motor.
    d. Open discharge valve slowly.
    e. 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.
    f. Check general mechanical operation of pump and motor.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Fire hoses are for field-acceptance tests only and are not property of Owner. Test equipment shall be calibrated within the last 12 mos. by a certified testing laboratory. Documentation shall be available at the time of final testing acceptance.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps, drivers, controllers, and pressure-maintenance pumps. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 13922

# SECTION 214000 - SURFACE WATER-STORAGE TANKS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes steel construction reservoirs for storage of fire-suppression water.

### 1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. NR: Natural rubber.

C. PVC: Polyvinyl chloride plastic.

### 1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Surface water-storage tank, including structural reinforcement and foundation, shall be capable of withstanding the effects of dead and live gravity loads. Roof to withstand code mandated snow loads. Construction and installation shall comply with all jurisdictional wind loading criteria.

B. Seismic Performance: Surface water-storage tank, including structural reinforcement and foundation, shall be capable of withstanding the effects of earthquake motions determined according to authorities having jurisdiction. Project is designated at Site Class B, Design Category B with Seismic response coefficient Cs=0.037. Refer to structural drawings for more seismic design data.

C. Thermal Movements: Surface water-storage tank, including structural reinforcement and foundation, shall allow for thermal movements resulting from the maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1.5 SUBMITTALS

A. Product Data: Include rated capacities, accessories, appurtenances, and furnished specialties for each surface water-storage tank indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details for each surface water-storage tank, including the following:

1. Tank, roof, and shell openings.
2. Safety railings and ladders.
3. Plans, elevations, sections, details, and attachments to other work.
4. Structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Power, signal, and control wiring.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:

1. Obstruction lighting.
2. Lightning protection.
3. Cathodic protection.
4. Tank heaters.

1.7 WARRANTY

A. The manufacturer shall warrant the tank structure against defects in workmanship and materials for a period of thirty years from date of shipment of the materials from the factory. The main liner shall be warranted against defects a minimum of ten years.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Employ a qualified structural engineer to prepare calculations, Shop Drawings, and other structural data for fabrication and erection of surface water-storage tanks.

1. Engineering Responsibility: Preparation of data for surface water-storage tanks, accessories, specified appurtenances, and concrete supports and foundations, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

2. Tank installer shall be trained in confined space protocols (OSHA) and be able to prove a minimum of fire years of tank building experience.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

C. Pipe Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

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

E. Comply with AWWA D103, "Factory-Coated Bolted Steel Tanks for Water Storage," and with AWWA M42, "Steel Water-Storage Tanks," for bolted-steel, surface water-storage tanks.

F. Comply with NFPA 22, "Water Tanks for Private Fire Protection," for surface water-storage tanks for fire-suppression water supply. Comply with NSF-61 and all OSHA requirements.

## PART 2 - PRODUCTS

### 2.1 BOLTED-STEEL RESERVOIRS

A. The water storage tank shall be insulated and of steel construction having a nominal capacity as determined by this contractor. Tank shall be sized for a 2 hour fire event based on fire pump size and assuming no make up water is available. Provide a 20% safety factor in storage volume.
   1. Tank shall be standard factory engineered galvanized steel, insulated and with liquid tight liners. The tank structure shall consist of corrugated galvanized steel wall sheets, roof panels , roof panel access hatch, roof ladder, anchor clips and necessary hardware for tank assembly.
   2. Bolted tank structure: Galvanized steel tank wall and roof panels shall be pre-punched for field assembly.
   3. Insulation: 2” of IsoSpray 20C04 FR (or equal) low viscosity, 2 component rigid polyurethane spray foam insulation applied to the interior of the metal walls and roof.
   4. Preliner: 8 oz. black geotextile preliner inside the tank covering the tank floor and walls of all surfaces which the liner could contact the tank structure.
   5. Main Liner: water containment system shall be welded seam, flexible membrane main liner. Liners shall be inside the tand utilizing liner hanger bolts, seal washers and grommets for suspension.
   6. Tanks shall be manufacturer from high yield strength US steel, (min. 57 ksi yield strength for wall panels) originally sourced in USA.
   7. Wall sheets shall be continuous annularly corrugated galvanized steel 20 gauge steel or heavier. All zinc coatings shall conform to G-115 or higher. Bottom wall sheets to have an inward return flange for bearing on foundation.
   8. One piece, 12 gauge or heavier galvanized steel die formed or welded anchor clips – minimum one clip per base wall panel.
   9. Tank roofs shall use single stage self-supporting roof sheets. Roofs shall meet all code required loading criteria with a peak equipment loading of 2000#. Roof sheets shall have 90 deg formed drip edge at eave and to be manufactured from G-115 galvanized steel conforming to ASTM A 446, Grade C, or greater. Bulb type neoprene eave seal and silicone caulking shall seal between the top wall panel and roof panel. Roof ladder cleats shall extend from eave to center.
   10. Tank Access: Provide roof access hole with cover having hinged cover located on the lower end of roof sheet. Bolted side access panels shall be located above floor on side panels.
   11. Tank Penetrations: Penetrations thru the floor or wall withing the water storage level shall be completed utilizing schedule 80 PVC flange sets bolted together with SS or brass hex

head cap screws with bonded sealing washers at all liquid side holes. Liquid seam sealant to be used to ensure effective sealing. Do not utilize flanges which use a single set of through bolts which sandwich the liner and flange faces to the steel wall.

12. Foundation: Foundation shall be a concrete pad that extends a minimum 9” outside the tank wall.
13. Hardware: All bolts and nuts shall be electro-galvanized with clear coat protective coating. Roof bolts shall have factory installed steel backed vinyl washers. Wall sheet bolts shall have slotted button heads for insertion from inside toward outside. All bolts shall be heat treated and meet SAE Grade 8.2 or stronger specs.
14. Flexible Membrane Liner: Liner shall have minimum rated thickness of 24 mil and a minimum finished coated weight of 22.0 ox/yd2. The liner shall be a PVC coated polyester fabric liner or polypropylene coated fabric reinforced liner. The liner shall be fabricated with minimum of 1.5” factory welded seams and shall have a poly rope in top hem for reinforcement. Metal or PVC grommets shall be evenly spaced along the top hem to facilitate liner hanging.
15. Anchor Clips: Anchor clips and bolts shall conform to structural design calculation package and shall meet site specific requirements for anchor tank in accordance with seismic, wind and other environmental conditions.,
16. Where Seismic anchor clips are required, an anchor “chair” shall be utilized with bolt extending thru base plate and thru a 1” hole in top plate of chair. A minimum of 9 15/15” shall separate the two plates to allow for stretch of the anchor bolt during a seismic event. The anchor chair shall be secured to the wall of the tank with no fewer than six 3/8” bolts.
17. Immersion: Provide a minimum of three (number and size to be determined by contractor) electric immersion heaters to prevent freezing of tank water. Heaters to be 460V/3 phase. Installed capacity to be based on an ambient air temperature of -20 deg F and sufficient to maintain a water temperature of 42 deg F. Coordinate power loads with electrical contractor.
18. Shell Roof: Comply with AWWA D103.
19. Overflow Piping: ASTM A 53/A 53M, Grade B, Schedule 40, welded-steel pipe with ASTM A 234/A 234M, Grade W.B., Schedule 40, carbon-steel butt-weld fittings.
20. Roof Hatch: Steel, hinged cover, 24 by 15 inches minimum with 4-inch neck and 2-inch downward overlap with hasp and lock, located over interior ladder and adjacent to exterior ladder.
21. Roof Manhole: Steel, removable, 20-inch- minimum-diameter cover with 4-inch neck and 2-inch- downward overlap with hasp and lock. Construct opening with capability of supporting ventilation fan.
22. Shell Sidewall Manholes: Two, steel, 24: x 24”.
23. Tank Vent: Steel pipe with stainless-steel screen, constructed to prevent entrance of rain, birds, and animals.
24. Foundation: Reinforced concrete. Refer to Section 03300 "Cast-in-Place Concrete."

## 2.2 SURFACE WATER-STORAGE TANK APPURTENANCES

A. Water-Level Controls: Automatic controls for maintaining water level in tank, with valves, piping, and audible and visual alarms to indicate the following:

1. High- and low-water levels.
2. Tank overflowing or tank not filling.

B. Obstruction Lighting: Comply with requirements of authorities having jurisdiction.

C. Provide Lightning Protection.

D. Cathodic Protection: Comply with AWWA D104.

E. Tank Heaters: Comply with NFPA 22 and with capacity to maintain 42 deg F water temperature inside surface water-storage tank.

## PART 3 - EXECUTION

### 3.1 STEEL, SURFACE WATER-STORAGE TANK INSTALLATION

A. Set top of reinforced-concrete foundation at least 6 inches above finish grade.

B. Install roof hatch near exterior ladder.

C. Install roof manhole near center of roof.

D. Install tank vent at center of roof.

E. Install two manholes in tank wall near grade.

F. Note: Installation personnel entering the tank must be trained on confined space OSHA protocols.

### 3.2 CONNECTIONS

A. Connect tanks to water-distribution piping.

B. Daylight overflow drainage with splash block. Connect tank drain to stormwater system with lockable shutoff valve.

C. Ground equipment.

D. Connect wiring.

### 3.3 SURFACE WATER-STORAGE TANK APPURTENANCE INSTALLATION

A. Install and adjust water-level control valves, piping, and alarms.

B. Install obstruction lighting according to authorities having jurisdiction.

C. Install lightning protection.

D. Install tank heaters according to NFPA 22.

E. Insulate and provide self-regulating and monitored heat trace to all exposed water and drain lines.

3.4 FIELD QUALITY CONTROL

A. Testing:

1. Leak Test: Comply with AWWA D100 and NFPA 22. Fill tanks with potable water and test for leaks after installation. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 CLEANING

A. Clean interior and exterior of surface water-storage tanks.

B. Disinfect surface water-storage tanks according to AWWA C652 and requirements of authorities having jurisdiction.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the following. Refer to Section 01820 "Demonstration and Training."

1. Obstruction lighting.
2. Water-level controls.
3. Tank heaters.

END OF SECTION 13220

# SECTION 22 00 00 - PLUMBING BASIC REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

A. Work included in 22 00 00 applies to Division 22 work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of plumbing systems for proposed project.

B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.

C. Definitions:
   1. Provide: To furnish and install, complete and ready for intended use.
   2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
   3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
   4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01 requirements, and approved by the Engineer prior to submitting bids for substituted items.
   5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

### 1.2 RELATED SECTIONS:

A. Contents of Section applies to Division 22 Contract Documents.

B. Related Work:
   1. Additional conditions apply to this Division including, but not limited to:
      a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
      b. Drawings
      c. Addenda
      d. Owner/Architect Agreement
      e. Owner/Contractor Agreement
      f. Codes, Standards, Public Ordinances and Permits

C. Related products/systems located in Division 23:
   1. Section 23 11 26 - Facility Fuel - Propane Gas Piping and Systems

1.3 REFERENCES AND STANDARDS

A. References and Standards per Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, individual Division 22 Sections and those listed in this section.

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
   1. State of Oregon:
      a. OAR Oregon Administrative Rules
      b. OESC Oregon Electrical Specialty Code
      c. OFC Oregon Fire Code
      d. OMSC Oregon Mechanical Specialty Code
      e. OPSC Oregon Plumbing Specialty Code
      f. OSSC Oregon Structural Specialty Code
      g. Oregon Elevator Specialty Code

C. General: Reference standards and guidelines include but are not limited to the latest adopted editions from:
   1. ADA Americans with Disabilities Act
   2. AHRI Air-Conditioning Heating & Refrigeration Institute
   3. ANSI American National Standards Institute
   4. ASCE American Society of Civil Engineers
   5. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
   6. ASHRAE Guideline 0, the Commissioning Process
   7. ASME American Society of Mechanical Engineers
   8. ASPE American Society of Plumbing Engineers
   9. ASSE American Society of Sanitary Engineering
   10. ASTM ASTM International
   11. AWWA American Water Works Association
   12. CFR Code of Federal Regulations
   13. CGA Canadian Gas Association
   14. CISPI Cast Iron Soil Pipe Institute
   15. CSA CSA International
   16. ETL Electrical Testing Laboratories
   17. EPA Environmental Protection Agency
   18. FDA Food & Drug Administration
   19. FM FM Global
   20. IAPMO International Association of Plumbing and Mechanical Officials
   21. GAMA Gas Appliance Manufacturers Association
   22. HI Hydraulic Institute Standards
   23. ISO International Organization for Standardization
   24. LEED Leadership in Energy and Environmental Design
   25. MSS Manufacturers Standardization Society
   26. NEC National Electric Code
   27. NEMA National Electrical Manufacturers Association
   28. NFGC National Fuel Gas Code
   29. NFPA National Fire Protection Association
   30. NRCA National Roofing Contractors Association
   31. NSF National Sanitation Foundation
   32. OSHA Occupational Safety and Health Administration
   33. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
   34. TEMA Tubular Exchanger Manufacturers Association
   35. TIMA Thermal Insulation Manufacturers Association
   36. UL Underwriters Laboratories Inc.

37. USDA United States Department of Agriculture

D. See Division 22 individual sections for additional references.

E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

G. Piping Insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials across the board.

## 1.4 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures as well as specific individual Division 22 sections.

B. Provide product submittals and shop drawings in one copy in paper format with electronic backup. Electronic format must be submitted via portable flash drive. For electronic format, provide one zip file per specification division containing a separate file for each specification section. For paper format, provide one common binder per specification division, with tabbed dividers for each specification section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.

C. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 22 sections.

D. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
   1. Label submittal to match numbering/references as shown in Contract Documents and schedules. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
   2. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference Division 22 Specification sections for specific items required in product data submittal outside of these requirements.
   3. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
   4. For vibration isolation of equipment, list make and model selected with operating load and deflection. Indicate frame type where required. Submit manufacturer's product data.
   5. See Division 22 sections for additional submittal requirements outside of these requirements.
   6. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of additional reviews at Engineer's

hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.

E. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-05 Chapter 13 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Refer to structural for building occupancy, seismic design category, and equipment importance factor.

F. Insert equipment/list equipment with importance factor greater than 1 and the importance factor.

G. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 22 Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26 submittals.

H. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.

I. Substitutions and Variation from Basis-of-Design:
   1. Basis-of-Design system components and controls for equipment are selected and sized based on the equipment specified as the first-named manufacturer, model number and supplemental additional options as indicated in the Contract Documents. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

J. Shop Drawings: Provide coordinated Shop Drawings which include physical characteristics of all systems, equipment and piping layout plans, and control wiring diagrams. Reference individual Division 22 sections for additional requirements for Shop Drawings outside of these requirements.
   1. Provide Shop Drawings indicating sanitary cleanout locations and type to Architect for approval prior to installation.
   2. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.

K. Samples: Provide samples when requested by individual sections.

L. Resubmission Requirements:
   1. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
      a. Resubmit for review until review indicates no exceptions taken or make "corrections as noted".
      b. When submitting drawings for Engineers re-review, clearly indicate changes on drawings and "cloud" any revisions. Submit a list describing each change.

M. Operation and Maintenance Manuals, Owners Instructions:
   1. Submit, at one time, one bound copy of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
      a. Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
      b. Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.
      c. Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
      d. Include copy of startup and test reports specific to each piece of equipment.
      e. Include copy of final water systems balancing log along with pump operating data.
      f. Include commissioning reports.
      g. Include copy of valve charts/schedules.
      h. Include Warranty per Division 00 and Division 01, Section 22 00 00 and individual Division 22 sections.
      i. Include product certificates of warranties and guarantees.
      j. Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
   2. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 22 00 00 article titled "Demonstration".
   3. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

N. Record Drawings:
   1. Maintain at site at least one set of drawings for recording “As-constructed” conditions. Indicate on Drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
   2. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
   3. At completion of project, input changes to original project on CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
   4. Invert elevations and dimensioned locations for water services, building waste, and storm drainage piping below grade extending to 5-feet outside building line.
   5. See Division 22 individual sections for additional items to include in record drawings.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Work and materials installed to conform with all local, State, Federal and other applicable laws and regulations.

B. Drawings are intended to be diagrammatic and reflect the Basis-of-Design manufacturers equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis-of-Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.

C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.

E. UL and CSA Compliance: Provide products which are UL and CSA listed

F. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.

G. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.

1.6 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 01, Section 22 00 00 and individual Division 22 sections.

B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty in Division 01 and the General Conditions. Confirm requirements in all Contract Documents.

1.7 COORDINATION DOCUMENTS

A. Advise Architect in the event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

B. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

C. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide like items from one manufacturer, including but not limited to fixtures, pumps, drains and equipment.

2.2 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities.

B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

D. Hazardous Materials:
   1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
   2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
   3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

A. See Division 01, General Requirements and Division 08 for products and installation requirements.

B. Confirm Access Panel requirements in Division 01, Division 08 and individual Division 22 sections. In the absence of specific requirements, comply with the following:
   1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
      a. Ceiling access panels to be minimum 24-inch by 24-inch required and approved size.
      b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
      c. Provide screwdriver operated catch provided.
         1) Drywall: Karp KDW.
         2) Plaster: Karp DSC-214PL.
         3) Masonry: Karp DSC-214M.
         4) 2 hour rated: Karp KPF-350FR.
         5) Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Division 01, Section 22 00 00 and individual Division 22 sections.

B. Install equipment requiring access (i.e., drain pans, drains, control operators, valves, motors, cleanouts and water heaters) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.

C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.

D. Earthwork:
   1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 22 Sections and the following:
      a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with the provisions of related earthwork sections/divisions. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
      b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
      c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:
   1. Confirm Firestopping requirements in Division 07. In absence of specific requirements, comply with individual Division 22 Sections and the following:
      a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Pipe Installation:
   1. Coordinate work to account for expansion and contraction of piping materials and building as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, expansion joints, sleeves, anchors or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products and rating for coordinating installation of piping systems.
   2. Include provisions for servicing and removal of equipment without dismantling piping.

G. Plenums:
   1. Provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

3.2 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, Section 22 00 00 and individual Division 22 sections.

B. General:
   1. Seismic Design Category: Refer to structural.
   2. Building Category: Refer to structural.
   3. Importance Factor (I-p): Refer to structural.
   4. Earthquake resistant designs for Plumbing (Division 22) equipment and distribution, i.e. motors, plumbing systems, piping, equipment, water heaters, boilers, etc. conform to regulations of jurisdiction having authority.
   5. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
   6. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.
   7. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.

C. Piping:
   1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA or local requirements.

D. Equipment:
   1. Provide means to prohibit excessive motion of plumbing equipment during earthquake.

3.3 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Division 01, Section 22 00 00 and individual Division 22 Sections.

B. Notify Architect or Engineer, in writing, at following stages of construction so that Architect may, at their option, visit site for review and construction observation:
   1. Underground piping installation prior to backfilling.
   2. Prior to covering walls.
   3. Prior to ceiling cover/installation.
   4. When main systems, or portions of, are being tested and ready for inspection by AHJ.

C. Bear responsibility and cost to make piping accessible, to expose concealed lines, or to demonstrate acceptability of the system. If Contractor fails to notify Architect at times prescribed above, costs incurred by removal of such work are the responsibility of the Contractor.

D. Final Punch:
   1. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

## 3.4 CONTINUITY OF SERVICE

A. Confirm requirements in Division 00 and Division 01. In absence of specific requirements, comply with individual Division 22 sections and the following:
   1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
   2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping, and wiring to point of connection.
   3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
      a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
   4. Organize work to minimize duration of power interruption.

## 3.5 CUTTING AND PATCHING

A. Confirm Cutting and Patching requirements in Division 01. In absence of specific requirements, comply with individual Division 22 sections and the following:
   1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
   2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section and will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
   3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
   4. Restore new or existing work that is cut and/or damaged to original condition. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
   5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

## 3.6 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

## 3.7 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00 and Division 01. In absence of specific requirements, comply with individual Division 22 Sections and the following:
   1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.

2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
3. Protect bright finished shafts, bearing housings and similar items until in service.

## 3.8 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Division 01, Section 22 00 00 and individual Division 22 sections.

B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, Section 22 00 00 and individual division 22 sections.

C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

## 3.9 CLEANING

A. Confirm cleaning requirements in Division 01, Section 22 00 00 and individual Division 22 sections.

B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

## 3.10 INSTALLATION

A. Confirm installation requirements in Division 00, Division 01, Section 22 00 00 and individual Division 22 sections.

B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of plumbing systems.
   2. Provide pump impellers to obtain Basis-of-Design design capacities.

D. Provide miscellaneous supports/metals required for installation of equipment, piping and ductwork.

## 3.11 PAINTING

A. Confirm requirements in Division 01 and Division 09. In absence of specific requirements, comply with individual Division 22 sections and the following:
   1. Ferrous Metal: After completion of plumbing work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces, i.e., hangers, hanger rods, equipment stands, with one coat of black enamel for interior suitable for hot surfaces.
   2. In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
   3. See individual equipment Specifications for other painting.
   4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
   5. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.
   6. Covers: Covers such as manholes, cleanouts and the like will be furnished with finishes which resist corrosion and rust.

## 3.12 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01. In absence of specific requirements in Division 01, comply with individual Division 22 sections and the following:
   1. Coordinate locations/sizes of access panels with Architect prior to work. Label access panels with engraved nameplates indicating function of panel.

## 3.13 DEMOLITION

A. Confirm Demolition requirements in Division 01 and Division 0. In absence of specific requirements, comply with individual sections in Division 22 and the following:
   1. Scope:
      a. It is the intent of these documents to provide necessary information and adjustments to plumbing system required to meet code, and accommodate installation of new work.
      b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
      c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
   2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.
   3. Unless specifically indicated on Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.
   4. Unless specifically indicated on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).

## 3.14 ACCEPTANCE

A. Confirm requirements in Division 00 and Division 01. In absence of specific requirements, comply with individual sections in Division 22 and the following:
   1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
      a. Testing and Balancing Reports
      b. Cleaning
      c. Operation and Maintenance Manuals
      d. Training of Operating Personnel
      e. Record Drawings
      f. Warranty and Guaranty Certificates
      g. Start-up/Test Document and Commissioning Reports

## 3.15 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 00, Division 01, Section 22 00 00 and individual Division 22 Sections.

B. Tests:
   1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in operation and maintenance manuals.
   2. During site evaluations by Architect or Engineer, provide an electrician with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

## 3.16 LETTER OF CONFORMANCE

A. Provide Letter of Conformance and copies of manufacturers' warranties and extended warranties with a statement that fire suppression items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance and copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

B. Warranties to begin at date of substantial completion.

## 3.17 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize plumbing equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

END OF SECTION

# SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Provision of materials, installation and testing of valving.
   1. Valves, General
   2. Gate Valves
   3. Balancing Valves
   4. Ball Valves
   5. Backflow Prevention Assemblies
   6. Thermostatic Mixing Valve

### 1.2 RELATED SECTIONS

A. Contents of Division 22 and Division 01, General Requirements apply to this section.

### 1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00 and Division 01, General Requirements.

### 1.4 SUBMITTALS

A. Submittals as required by Section 22 00 00 and Division 01, General Requirements.

### 1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, meet the following:
   1. NSF 61 Appendix 'G' compliant.
   2. ISO 9001 Certified.
   3. IAPMO Certified for Low Lead.

### 1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00 and Division 01, General Requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Valves - General:
   1. Apollo

2. Armstrong
3. Crane
4. Griswold
5. Hammond
6. Hays
7. Jenkins
8. Josam
9. Milwaukee
10. Mueller
11. Nibco
12. Watts
13. Or approved equivalent.

B. Backflow Preventors:
1. Apollo
2. Watts
3. Or approved equivalent.

C. Balancing Valves:
1. Griswold
2. Hays
3. Armstrong CBV
4. Or approved equivalent.

D. Backwater Valve:
1. Watts
2. Zurn
3. Or approved equivalent.

E. NSF Valves;
1. Kennedy
2. Nibco
3. Or approved equivalent.

F. Thermostatic Mixing Valves:
1. Holby Tempering Valve
2. Lawler Series 66
3. Leonard Type TM
4. Powers LFMM430 (Lead Free)
5. Symmons Temp Control Series 5
6. Or approved equivalent.

G. Backflow Prevention Assemblies - Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications:
1. Febco 860-with 650A.
2. Conbraco 40-210-AGD.
3. Wilkins 375-XL-SAG.
4. Watts 919-QT-S valve with 919AGC.
5. Or approved equivalent.

H. Spill Resistant Pressure Vacuum Breaker:
1. Febco
2. Wilkins
3. Conbraco
4. Or approved equivalent.

I. Atmospheric Vacuum Breaker:
   1. Conbraco Apollo 38-201
   2. Watts 288 A-C
   3. Wilkins 35VCH
   4. Cash Acme V101C
   5. Or approved equivalent.

## 2.2 VALVES - GENERAL

A. General:
   1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
   2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6-inches and smaller. Provide gear operators for quarter-turn valves 8-inches and larger and plug valves installed over 5-feet above finished floor.
   3. Valve Identification: Manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

B. Valves in Insulated Piping: With 2-inch stem extension and following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation on valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied.
   3. Butterfly Valves: With extended neck.

C. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves, ASME B16.5 for steel valves.
   2. Grooved: With grooves according to AWWA C606.
   3. Solder Joint: With sockets according to ASME B16.18.
   4. Threaded: With thread according to ASME B1.20.1.

D. Valve Bypass and Drain Connections: MSS SP-45.

E. Building Service:
   1. Shutoff and Isolation Valves:
      a. Pipe Sizes 3-inches and Smaller: Ball Valve.
      b. Pipe Sizes 4-inches and Larger: Butterfly Valve.
   2. Drain Service: Ball valves.
   3. Strainer Blow-Off: Ball Valve.
   4. Bypass Around Pressure-Reducing Valves: Globe Valves.
   5. Check Valves: Swing.

## 2.3 GATE VALVES

A. Gate Valves - Class 125:
   1. 2-inches and Smaller: MSS SP-80, Class 125, ASTM B62 cast bronze composition body, bonnet and solid disc, copper-silicon non-rising stem, brass packing gland, teflon impregnated packing and malleable iron hand-wheel.

B. Gate Valves - Class 150:
   1. 2-inches and Smaller: Class 150, MSS SP-80, ASTM B62 cast bronze body, bronze bonnet, bronze wedge, non-rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel.

2.4 BALANCING VALVES

A. Maximum 125 PSIG System Working Water Pressure.

B. Manual Set Balancing Valves:
   1. Valves are to be of the "Y" pattern, equal percentage globe-style and provide three functions:
      a. Precise flow measurement.
      b. Precision flow balancing.
      c. Positive drip-tight shut-off.
   2. Valve to provide multi-turn, 360 degree adjustment with micrometer type indicators located on the valve handwheel. Valves have a minimum of five full 360 degree handwheel turns. 90 degree circuit-setter style ball valves are not acceptable. Valve handle to have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. Valves to be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi to have two 1/4-inch threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves to be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug to be brass. The handwheel to be high-strength resin.
   3. 2-1/2-inch and Larger: Valves are to be of the "Y" pattern, equal percentage globe-style and provide three functions:
      a. Precise flow measurement.
      b. Precision flow balancing.
      c. Positive drip-tight shut off. Valve to provide multi-turn, 360 degree adjustment with micrometer type indicators location on the valve handwheel. Valves to have a minimum of five full 360 degree handwheel turns. 90 degree circuit-setter style ball valves are not acceptable. Valve handle to have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. Valve body to be either cast iron with integrated cast iron flanges (2-1/2-inch to 12-inch) or ductile iron with industrial standard grooved ends (2-1/2-inch to 12-inch). Valve stem and plug disc to be bronze with handwheel that permits multi-turn adjustments. Sizes 2-1/2-inch and 3-inch - five turns, sizes 4-inch to 6-inch - 6 turns, sizes 8-inch to 10-inch - 12 turns and size 12-inch - 14 turns. Flange adapters to be provided to prevent rotation.

2.5 BALL VALVES

A. 4-inches and Smaller: MSS SP-110, 400-600 PSI, two-piece full port ball configuration, bronze body, extended soldered ends for copper pipe and threaded ends for iron pipe, brass or stainless steel ball, no chrome plated ball valves are approved, Teflon seat, or brass stem. Apollo 70LF 100 Series two-piece.

2.6 BACKFLOW PREVENTION ASSEMBLIES

A. General: Assemblies model numbers listed below are for general comparison. Project specific model numbers to be verified contractor as approved by jurisdiction where project is located.

B. Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications:
   1. 2-inches and Smaller: Assembly consists of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and pressure-differential relief valve located between two positive seating check valves and comply with requirements of ASSE Standard 1013 and AWWA C511. Bronze construction, threaded ends, stainless steel

internal parts, FDA strainer, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.

C. Double Check Valve Assembly (DCVA) for Low Hazard Applications:
   1. 2-inches and Smaller: Assembly consists of shutoff ball valves in inlet and outlet, and FDS strainer on inlet. Assemblies include test cocks and two positive seating check valves and comply with requirements of ASSE Standard 1015 and AWWA C510. Bronze construction, threaded ends, and stainless steel internal parts.
   2. 2-1/2-inches and Larger: Assembly consists of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and two positive seating check valves and comply with requirements of ASSE Standard 1015 and AWWA C510. Epoxy coat cast iron body construction, strainer flanged ends, and stainless steel internal parts.

D. Spill Resistant Pressure Vacuum Breaker: Watts Model 800MCQT with 777S "Y" strainer.

E. Atmospheric Vacuum Breaker: Assembly consists of a bronze vacuum breaker body with silicone disc, and full size orifice. Device to be IAPMO listed, meet ASE standard 1001, and ANSI standard A113.1.1 rough chrome plate finish.

## 2.7 THERMOSTATIC MIXING VALVE

A. Thermostatic type with liquid filled motor, bronze body construction, corrosion resistant, materials, union end stops, check inlets with strainers, 0-200 degree farenheit dial thermometer and discharge shut-off valve. Mixing valves to meet ASSE 1017.

B. Install mixing valve per manufacturer's instruction manual.

C. Maximum required delta temperature differential between hot water supply temperature and delivery temperature is 15 degrees F. Set valve outlet temperature per drawing requirements.

D. Flow from the tempered water circulating pump to be split to mixing valve and building hot water heating system.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves and weld ends.
   3. Set angle, gate and globe valves closed to prevent rattling.
   4. Set ball valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Do not attempt to repair defective valves; replace with new valves.

E. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

F. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter and cap on chain for each valve that must be installed with stem below horizontal plane. Ensure installation provides full stem movement.

G. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

H. Mechanical Actuators: Install with chain operators where indicated. Extend chains to 5-feet above floor and hook to clips to clear aisle passage.

I. Stem Selection: Outside screw and yoke stems, except provide inside screw, non-rising stem where space prevents full opening of OS&Y valves.

J. Seats: Renewable seats, except where otherwise indicated.

K. Installation of Check Valves:
   1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow. Only install where there is 10 pipe diameters of straight pipe upstream of valve.
   2. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow.
   3. Lift Check Valves: Install in piping line with stem vertically upward, position for proper direction of flow.

L. Balancing Valves: Install with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream from the balancing valve should be free of any fittings. When installed, easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided. Mounting of valve in piping must prevent sediment build-up in metering ports.

## 3.2 VALVE ADJUSTING AND CLEANING

A. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Valve Identification. Tag valves per Section 22 05 53, Identification for Plumbing Piping and Equipment.

## 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated on Drawings, use the following:
   1. Shutoff Service: Ball valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Valves, except wafer types, with the following end connections.
   1. For Copper Tubing, 2-inches and Smaller. Threaded ends except where solder-joint valve-end.

2. For Copper Tubing, 2-1/2-inches to NPS 4-inches. Flanged ends except where threaded valve-end.
3. For Steel Piping, 2-inches and Smaller: Threaded ends.
4. For Steel Piping, 2-1/2-inches to NPS 4-inches: Flanged ends except where threaded valve-end.

## 3.4 BACKFLOW PREVENTERS

A. Install where indicated, and where required by code. Where practical, locate in same room as equipment being protected.

B. Submit product cut sheets to local AHJ for approval prior to purchase.

C. Install as close to wall as possible with clearances for access and maintenance as required by AHJ.

D. Coordinate exact location of installation and type of backflow device serving a particular piece of equipment with AHJ and Architect prior to purchase and installation.

E. Provide wall/floor brackets that are of fully welded, hot dipped galvanized construction, fabricated to meet field conditions. Mount backflow preventer to brackets using cadmium plated "U" type bolts and nuts.

F. Contact: Contact local water district/backflow specialist and request backflow installation literature. Install backflow devices per UPC and local water district/backflow specialist requirements.

G. Route waste piping from air gap waste fitting concealed within walls to point of air gap termination at indirect waste receptor.

## 3.5 PRESSURE REGULATING

A. Provide inlet and outlet ball valves, and globe valve bypass. Provide pressure gauge on valve outlet.

B. Provide factory startup on automatic control valves.

END OF SECTION

# SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Provision of materials, installation and testing of:
   1. Piping Hangers and Supports
   2. Wall and Floor Sleeves
   3. Anchors
   4. Flashing
   5. Miscellaneous Metal
   6. Miscellaneous Materials

### 1.2 RELATED SECTIONS

A. Contents of Division 22 and Division 01, General Requirements apply to this section.

### 1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, meet the following:
   1. Hanger spacing installation and attachment to meet all manufacturers requirements and Code requirements.

### 1.4 SUBMITTALS

A. Submittals as required by Section 22 00 00 and Division 01, General Requirements.

### 1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, meet the following:
   1. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
      a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.
   3. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems whose products have been in satisfactory use in similar service for not less than 10 years.

4. Support systems to be supplied by a single manufacturer.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00 and Division 01, General Requirements.

1.7 PERFORMANCE REQUIREMENTS

A. General - Provide pipe and equipment hangers and supports in accordance with the following:
   1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for conduit, piping, and cutwork are not shown on the Drawings, the contractor is responsible for their design.
   2. Connections to structural framing not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Engineered Support Systems:
   1. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
   2. Equipment and piping support frame anchorage to supporting slab or structure.

C. Provide channel support systems, for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

D. Provide heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

E. Provide seismic restraint hangers and supports for piping and equipment.

F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Pipe Hangers/Supports:
   1. B-Line Systems, Inc.
   2. Anvil Corp.
   3. Erico Co., Inc.
   4. Or approved equivalent.

B. Pipe Guides:
   1. Flexonics
   2. Mason Industries
   3. Amber-Bush
   4. Metraflex
   5. Pipe Shields
   6. Swebco
   7. Flex-Weld
   8. Advanced Thermal Systems
   9. Or approved equivalent.

C. Channel Support Systems:
   1. B-Line Systems, Inc.
   2. Anvil Corp., Power-Strut Unit.
   3. Erico Hanger Co., Inc.; O-Strut Div.
   4. Unistrut Corp.
   5. Or approved equivalent.

D. Thermal-Hanger Shield Inserts:
   1. Erico Hanger Co., Inc.
   2. Pipe Shields, Inc.
   3. Rilco Manufacturing Co., Inc.
   4. Or approved equivalent.

E. Powder-Actuated Fastener Systems:
   1. Gunnebo Fastening Corp.
   2. Hilti, Inc.
   3. ITW Ramset/Red Head.
   4. Masterset Fastening Systems, Inc.
   5. Or approved equivalent.

F. Pipe Alignment and Secondary Supports:
   1. HoldRite
   2. Starquick
   3. Or approved equivalent.

G. Below Grade Pipe Sleeves:
   1. Thunderline Corporation "Link Seal".
   2. Or approved equivalent.

H. Anchors:
   1. Anchor-It
   2. Hilti Hit System
   3. Epcon System
   4. Power Fast System
   5. Or approved equivalent.

## 2.2 PIPING HANGERS AND SUPPORTS

A. Horizontal Piping Hangers and Supports - Horizontal and Vertical Piping, and Hanger Rod Attachments:
   1. Factory fabricated horizontal piping hangers and supports to suit piping systems, in accordance manufacturer's published product information.
   2. Use only one type by one manufacturer for each piping service.
   3. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.
   4. Provide copper-plated hangers and supports for uninsulated copper piping systems.
   5. Provide padded pipe hangers, clamps and supports for thermoplastic piping system.

B. Pipe Hangers, Slides and Clamps:
   1. Hanger Rods: Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.
   2. Hanger Rod Couplings: Malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.

3. Pipe Rings for Hanger Rods: Pipe sizes 2-inch and smaller, MSS SP Type 6 or Type 10, or approved equivalent. Pipe sizes 2-1/2-inches and larger, clevis type hangers with adjustable nuts on rod. MSS SP Type 1. Pipe rings to have same finish as hanger rods.
4. Pipe Slides: Type 35 reinforced teflon slide material (3/32-inch minimum thickness) bonded to steel; highly finished steel or stainless steel contact surfaces to resists corrosion; 60-80 PSI maximum active contact surface loading; steel parts 3/16-inch minimum thickness; attachment to pipe and framing by welding.
5. Pipe Guides:
   a. Furnish and install pipe guides on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides securely to pipe and structure. Contact with chilled water pipe not to permit heat to be transferred in sufficient quantity to cause condensation on any surface.
   b. Furnish and install guides approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Guides are not to be sued as supports and are in addition to other pipe hangers and supports.
6. Channel Type Pipe Hanging System: Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33, one side of channel to have a continuous slot with in turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.

C. Building Attachments:
   1. Factory fabricated attachments to suit building substructure conditions and in accordance with manufacturer's published product information.
   2. Select size of building attachments to suit hanger rods.

D. Saddles and Shields:
   1. Factory fabricated saddles or shields under piping hangers and supports for insulated piping.
   2. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12-inches in length (4-inch pipe and larger to be three times longer than pipe diameter).

E. Thermal-Hanger Shield Inserts: 100-PSI (690-kPa) minimum compressive strength insulation, encased in sheet metal shield.
   1. Material for Cold Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with vapor barrier.
   2. Material for Hot Piping: Water-repellent-treated ASTM C533, Type 1 calcium silicate.
   3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
   4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
   5. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.

F. Roller Hangers:
   1. Adjustable roller hanger. Black steel yoke, cast iron roller. MSS Type 41.

G. Concrete Inserts:
   1. Malleable iron body, hot tipped galvanized finish. Lateral adjustment. MSS Type 18.

H. Continuous Concrete Insert:
   1. Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.

I. Beam Clamps:
   1. MSS Type 19 and 23, wide throat, with retaining clip.

2. Universal Side Beam Clamp: MSS Type 20.

J. Hangers for Pipe Size 2-inches and Smaller:
1. Adjustable swivel ring hanger, UL listed, Type 6 or Type 10.

K. Hangers for Pipe Size 2-1/2-inches and Larger:
1. Adjustable clevis type, UL listed, Type 1.

L. Riser Clamps:
1. Steel, UL listed. MSS Type 8.

M. Plumbers Tape:
1. Not permitted as pipe hangers or pipe straps.

N. Pipe Alignment and Secondary Support Systems:
1. Secondary Pipe supports for general applications (Non-Acoustical).
   a. Supports will be manufactured in compliance with IAPMO Product Standard PS 42-96. All products provided will be listed by IAPMO for secondary pipe support.
   b. Supports may be used when sound and/or vibration transfer is not a concern.
2. Secondary pipe supports for sound and vibration attenuation (Acoustical).
   a. Supports will be manufactured in compliance with IAPMO Product Standard PS 42-96. All products provided will be listed by IAPMO for secondary pipe support.
   b. Acoustical pipe supports will be manufactured and installed in compliance with International Organization for Standardization (ISO) 3822-1 with current amendments.
   c. Supports will be used when sound and/or vibration transfer is a concern. Locations where acoustical supports will be provided include but are not limited to partition walls between living units, tenant spaces, retail units, mechanical rooms, and lobbies.
   d. Support products:
      1) Support to Wall Brace and Wall Stud Penetrations: HoldRite 261, 262, 263, and 264, or approved equivalent.
      2) Pipe Wrap for Pipe Clamps and Channel-Mounted Pipe Clamps: HoldRite 270, or approved equivalent.
      3) Pipe Wrap for Pipe Hangers: HoldRite 271, 272-2, and 272-4, or approved equivalent.
      4) Drop-Ear Fitting Support: HoldRite 265, or approved equivalent.
      5) Floor Riser Isolation Pads: HoldRite 275-T, or approved equivalent.
      6) Floor Isolation Pads (General Applications): HoldRite 274, 275, 276, and 278, or approved equivalent.

## 2.3 WALL AND FLOOR SLEEVES

A. Below Grade or High Water Table Areas:
1. "Link-Seal" Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Provide Type S unless otherwise noted. Thunderline Corporation, or approved equivalent.

B. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.

C. Fabricated Accessories:
1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:

a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.
b. Sleeve Sizes 5-6-inches: 16 gauge.
c. Sleeve Sizes 7-inches and Larger: 14 gauge.
d. Fire-Rated Safing Material.
    1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 lbs./cu.ft. density with melting point of 1985F and K value of 0.24 at 75F.
    2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100F to 1200F service with K value of 0.40 at 150F.

## 2.4 ANCHORS

A. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer.

B. Anchor Bolts:
    1. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
    2. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
    3. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.

## 2.5 FLASHING

A. Steel Flashing: 26 gauge galvanized steel.

B. Safes: 8 mil thick neoprene.

C. Caps: Steel, 22 gauge minimum, 16 gauge at fire-resistant structures.

## 2.6 MISCELLANEOUS METAL

A. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on Drawings or otherwise not shown on drawings that are necessary for completion of the project. The Contractor is responsible for their design.
    1. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

B. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.

C. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.

D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.

E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

G. Provide hot dipped galvanized components for items exposed to weather.

## 2.7 MISCELLANEOUS MATERIALS

A. Powder-Actuated Drive-Pin Fasteners: Powder actuated type, drive pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Grout: ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   2. Properties: Nonstaining, noncorrosive, and non gaseous.
   3. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

D. Provide galvanized components for items exposed to weather.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.

## 3.2 PREPARATION

A. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

B. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

## 3.3 FABRICATION - MISCELLANEOUS METALS

A. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on Drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of

structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.

B. Finishes:
   1. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
   2. Metal in contact with Concrete, Masonry and Other Dissimilar Materials:
      a. Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
   3. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

## 3.4 INSTALLATION

A. Building Attachments:
   1. Install within concrete or on structural steel or wood. Attachment to Wood Structure: Provide MSS Type 34 for attachment to wooden beam or approved attachment for a wood structure.
   2. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.
   3. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

B. Hangers and Supports:
   1. Pipe Hanger and Support Installation: Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. For horizontally hung grooved-end piping, provide a minimum of 2 hangers per pipe section.
   2. Pipe Ring Diameters:
      a. Uninsulated and Insulated Pipe, except where oversized pipe rings are specified: Ring inner diameter to suit pipe outer diameter.
      b. Insulated Piping Where Oversized Pipe Rings are Specified and Vibration Isolating Sleeves: Ring inner diameter to suit outer diameter of insulation or sleeve.
   3. Oversize Pipe Rings: Provide oversize pipe rings of 2-inch and larger size.
   4. Pipe Support Brackets: Support pipe with pipe slides.
   5. Steel Backing in Walls: Provide steel backing in walls to support fixtures and piping hung from steel stud walls.
   6. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
      a. Field assemble and install according to manufacturer's written instructions.
   7. Pipe Guides:

a. Install on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides to pipe structure. Contact with chilled water pipe does not permit heat to be transferred in sufficient quantity to cause condensation on any surface.
b. Install approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Do not use as supports. Provide in addition to other required pipe hangers and supports.

8. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field -fabricated, heavy-duty trapezes.
   a. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   b. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1
9. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers.
10. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe.
11. Do not support piping from other piping.
12. Fire protection piping will be supported independently of other piping.
13. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.
14. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
15. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
16. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
17. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
18. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
19. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
20. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping" is not exceeded.
21. Insulated Piping: (comply with the following)
    a. Attach clamps and spacers to piping.
       1) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
       2) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
       3) Do not exceed pipe stress limits according to ASME B31.9.
    b. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
       1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
    c. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields to span arc of 180 degrees.

1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.

d. Shield Dimensions for Pipe, not less than the following:
1) NPS 1/4 to NPS 3-1/2 (DN8 to DN 90): 12-inches long and 0.048-inch thick.
2) NPS 4 (DN100): 12-inches long and 0.06-inch thick.
3) NPS 5 and NPS 6 (DN125 and DN150): 18-inches long and 0.06-inch thick.
4) NPS 8 to NPS 14 (DN200 to DN350): 24-inches long and 0.075-inch thick.
5) NPS 16 to NPS 24 (DN400 to DN600): 24-inches long and 0.105-inch thick.

e. Pipes NPS 8 (DN200) and Larger: Include wood inserts.

f. Insert Material: Length at least as long as protective shield.

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

22. Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, IT rooms, MPOE rooms, and other electrical or electronic equipment spaces and enclosures, operating rooms, procedure rooms, MRI room, CT Scan rooms and the like. Within equipment rooms, provide minimum 3-feet lateral clearance from all sides of electric switchgear panels. Do not route piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact pipe routing to provide proper clearance with such items.

23. Hanger Spacing to meet all manufacturers requirements.

C. Bolting:
1. General: Provide bored, drilled or reamed holes for bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand sawn holes will not be accepted.

D. Anchor Bolts:
1. General: Install anchor bolts for mechanical equipment, piping and ductwork as required. Tightly fit and clamp base-supported equipment anchor bolts at equipment support points. Provide locknuts where equipment, piping and ductwork are hung.
2. Anchor bolts (Cast-In-Place): Embed anchor bolts in new cast-in-place concrete to anchor equipment. Install a pipe sleeve around the anchor bolt for adjustment of the top 1/3 of the bolt embedment; sizes and patterns to suit the installation conditions of the equipment to be anchored.

E. Pipe Anchors:
1. General: Provide anchors to fasten piping which is subject to expansion and contraction, and adjacent to equipment to prevent loading high forces onto the equipment.

F. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.

G. Fabricated Pipe Sleeves:
1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeve diameter to be determined by local seismic clearance requirements, and by waterproofing requirements.
2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1-inch above floor finish.
3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
4. Seal each end airtight with a resilient nonhardening sealer.

H. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:

1. Install fabricated pipe sleeve.
2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D. with specified material.
3. Seal each end airtight with a resilient nonhardening UL listed fire resistant ASTM 814.

I. Piping penetrations through fire-rated (1 to 3 hour) assemblies:
1. Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.
2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814.

J. Vertical Piping:
1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
2. Riser clamps to be directly under fitting or welded to pipe.
3. Riser to be supported at each floor of penetration.
4. Provide structural steel supports at the base of pipe risers. Size supports to carry forces exerted by piping system when in operation.

## 3.5 MISCELLANEOUS METALS

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts. Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.

C. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items, which are to be built into concrete masonry or similar construction.

D. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

E. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
1. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

## 3.6 ADJUSTING AND PAINTING

A. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping and equipment to proper level and elevations.

B. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

## 3.7 FLASHING

A. Flash and counterflash where equipment passes through weather or waterproofed walls, floors, and roofs.

B. Flash vent soil pipes with flashings per Division 01 requirements.

C. Flash floor drains over finished areas and roof drains, 10-inches clear on sides, minimum 36-inches x 36-inches sheet size. See Division 01. Fasten flashing to drain with clamping device.

D. Install built up fixtures (mop sinks, shower stalls, shower floors) with water sealing systems/membranes to meet Code and as prescribed by Division 01 and Section 22 00 00, Plumbing Basic Requirements. Meet all Code testing requirements. Provide drainage devices with appropriate flanges, clamps, etc. to meet these installation requirements and ensure a water tight installation.

## 3.8 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

## 3.9 TESTING

A. Powder-Actuated Inserts: Test powder-actuated insert attachments with a minimum load of 100 pounds.

END OF SECTION

# SECTION 22 07 00 - PLUMBING INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Provision of materials, installation and testing of:
   1. Type 1, Fiberglass Pipe Insulation
   2. Type 5, Fiberglas Equipment Insulation
   3. Type 7, ADA Accessible Lavatory/Sink Insulation Kit
   4. Jacketing
   5. Accessories
   6. Pipe Fitting Insulation Covers

### 1.2 RELATED SECTIONS

A. Contents of Division 22 and Division 01, General Requirements apply to this section.

### 1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, meet the following:
   1. Piping insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials across the board.

### 1.4 SUBMITTALS

A. Submittals as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, provide:
   1. Installer qualifications.
   2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
   3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
   4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
   5. Submit manufacturer's installation instructions.

### 1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00 and Division 01, General Requirements apply to this section.

B. In addition, meet the following:

1. Installer to have minimum 5 years experience in the same business.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00 and Division 01, General Requirements.

1.7 FIRE HAZARD CLASSIFICATION

A. Maximum fire hazard classification of composite insulation construction as installed to be not more than a flame spread of 25, fuel contributed of 50 and smoke developed of 50 as tested by ASTM E84 (NFPA 255) method.

B. Test pipe insulation in accordance with requirements of UL "Pipe and Equipment Coverings".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General:
1. Armacell LLC Armaflex
2. Certainteed
3. Johns Manville
4. Knauf
5. Owens-Corning
6. PPG
7. Or approved equivalent.

B. Type 7, ADA Accessible Lavatory/Sink Insulation Kit:
1. IPS/Truebro
2. McGuire/Pro-Wrap
3. Plumberex/Pro-Extreme
4. Brocar Trap Wrap
5. Or approved equivalent.

2.2 TYPE 1 FIBERGLASS PIPE INSULATION

A. Glass Fiber: ASTM C547; rigid molded, noncombustible.
1. Thermal Conductivity Value: 0.27 BTU*in/(hr*sf*F) at 75 degrees F.
2. Maximum Service Temperature: 850 degrees F.
3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, with self sealing longitudinal laps and butt strips or vapor barrier mastic.

2.3 TYPE 5, FIBERGLASS EQUIPMENT INSULATION

A. Flexible Fiberglass Blanket: ASTM C612; flexible.
1. Thermal Conductivity Value: 0.24 BTU*in/(hr*sf*F) at 75 degrees F.
2. Maximum Service Temperature: 450 degrees F.

2.4 TYPE 7, ADA ACCESSIBLE LAVATORY/SINK INSULATION KIT

A. P-traps, trap arms, tail pieces, hot water and cold water insulating guards. Molded closed cell vinyl with nylon fasteners, paintable. Thermal conductivity; K = 1.17 (BTU*in/(hr*sf*F) at 75 degrees F mean temperature. Provide accessories as required for complete installation covering all exposed waste piping, water piping, stops and supplies. Color white.

2.5 JACKETING

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

B. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner. ASTM B 209.

C. Stainless Steel Jacket: Type 304 stainless steel, 0.010-inch, (smooth/corrugated) finish. ASTM A 666

2.6 ACCESSORIES

A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have same flame and smoke component ratings as insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

2.7 PIPE FITTING INSULATION COVERS

A. PVC Plastic Fitting Covers: Schuller Zeston 2000 or approved equivalent. One-piece molded type fitting covers and jacketing material, gloss white. Connections: Tacks; pressure sensitive color matching vinyl tape.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Do not apply insulation until pressure testing of piping has been completed. Do not apply insulation over heat tracing temperature maintenance until system tested. Do not apply insulation until piping has been inspected.

B. Examine areas and conditions under which insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to be insulated.

3.3 INSTALLATION

A. Insulation: Continuous through walls, floors, partitions except where noted otherwise.

B. Piping and Equipment:
   1. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
   2. Cover insulation on pipes above ground, outside of building, with aluminum jacketing. Position seam on bottom of pipe.

3.4 PROTECTION AND REPLACEMENT

A. Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

3.5 FIBERGLASS INSULATION

A. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

B. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.

3.6 LABELING AND MARKING

A. Provide labels, arrows and color coding on piping and ductwork. Attach labels and flow direction arrows to jacketing per 22 05 23.

3.7 PIPING SURFACES TO BE INSULATED

| Item to be Insulated | System Insulation Type | Pipe Size | Insulation Thickness |
|---|---|---|---|
| Hot Water Piping Above Grade | 1 | Runouts up to 2-inch<br>Mains=<2-inch<br>Mains >2-inch | 1-inch<br>1-inch<br>1-1/2-inch |
| Hot Water Circulation Piping Above Grade | 1 | Runouts, up to 2-inch<br>Mains =<2-inch<br>Mains >2-inch | 1-inch<br>1-inch<br>1-1/2-inch |

| | | | |
|---|---|---|---|
| Cold Water Except Minor Branch Piping Within Walls Serving Fixtures | 1 | =<2-inch | 1/2-inch |
| Domestic Water Piping Exposed to Weather | 1 | All | 1-1/2-inch |
| Piping with Heat Tracing | 1 | =<2-inch<br>> 2-inch | 1-inch<br>1-1/2-inch |
| Rain Conductors Above Grade Horizontal Piping | 1 | All | 1/2-inch |
| Roof Drain Underbodies | 5 | N/A | 1-inch |
| Overflow Roof Drain Underbodies | 5 | N/A | 1-inch |
| ADA Accessible Lavatory/Sink | 7 | All | As Listed |
| Condensate Drain Piping | 1 | All | 1/2-inch |

## 3.8 FIBERGLASS INSULATION

A. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

B. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.

## 3.9 ADA ACCESSIBLE LAVATORIES/SINKS

A. Provide lavatory/sink insulation kit. Install per manufacturers requirements.

## 3.10 INSULATED PIPE EXPOSED TO WEATHER

A. Where piping is exposed to weather, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Provide heat tracing on piping subject to freezing. See Section 22 05 33.

## 3.11 FLEXIBLE ELASTOMERIC PLASTIC PIPE INSULATION

A. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and undergrade with two coats of finish as recommended by manufacturer.

3.12 FLEXIBLE ELASTOMERIC TUBING

A. Slip insulation over piping or if piping is already installed, it should be slit and snapped over piping. Joints and butt ends must be adhered with 520 adhesive.

3.13 CALCIUM SILICATE PIPE INSULATION

A. Install in accordance with manufacturer's instructions. Seal canvas jacket tight to insulation at lap joints. Continuous insulation over pipe, fittings and supports or hangers. No holidays or gaps permitted.

3.14 FOAMGLASS INSULATION

A. Install in accordance with manufacturer's instructions for below grade installation.

3.15 STORAGE TANKS

A. Cover with hydrous calcium silicate, 2-inches thick. Finish with canvas jacket and adhesive. Overlap joints minimum of 4-inches. Apply two coats latex paint; color selected by Architect.

3.16 INSULATION SHIELDS

A. Provide full size diameter hangers and shields (18 gauge minimum) for cold piping. Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation section at insulation shields for lines 1 1/2-inches and larger (hot and cold piping).

B. Install in accordance with manufacturer's instructions for below grade installation.

END OF SECTION

# SECTION 22 10 00 - PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work included: Provision of materials, installation and testing of:
   1. Sanitary, Drainage (Rain/Stormwater) DWV Piping, Buried Within 5-feet of Building
   2. Sanitary DWV Piping, Above Grade
   3. Water Piping, Buried Within 5-feet of Building
   4. Hot and Cold Water Above Grade
   5. Condensate Piping
   6. Primer Piping
   7. Flanges, Unions, and Couplings
   8. Ductile Iron Pipe and Fittings
   9. ABS (Acrylonitrile-Butadiene-Styrene) Pipe and Fittings
   10. Wall and Floor Sleeves

### 1.2 RELATED SECTIONS

A. Contents of Division 22 and Division 01, General Requirements apply to this Section.

### 1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, meet the following:
   1. NSF 61 Appendix 'G' - Low Lead Products Used in Drinking Water Systems (less than or equal to 25 percent lead).

### 1.4 SUBMITTALS

A. Submittals as required by Section 22 00 00 and Division 01, General Requirements.

### 1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00 and Division 01, General Requirements.

### 1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00 and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Uponor

B. Cerro

C. Tyler

D. Charlotte

E. Nibco

F. Orion

G. or approved equivalent.

2.2 GENERAL

A. Provide pipe, tube and fittings of the same type, fitting requirements, grade, class and the size and weight indicated or required for each service, as indicated in other Division 22 Specifications. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

B. Manufactured materials delivered, new to the project site and stored in their original containers.

C. Product Marking: Each item to be furnished with legible markings indicating: name brand and manufacturer, manufacturing process, heat number and markings as required per ASTM and UL/FM Standards.

D. Applicable Standards
   1. Steel pipe to conform to ASTM and ANSI Standards as specified in this section.
   2. Copper piping to conform to ASTM B88, B306 and B208 and the standards of Copper Development Association (CDA), and American Welding Society, (AWS).
   3. Cast Iron Piping to conform to standards of ASTM A-74 and CISPI HS-74, CISPI 301 and FM 1680.
   4. Manufacturer's Standards Society (MSS) for valving and support reference standard.
   5. American Waters Association (AWWA) for Valving Assembly Standards.
   6. American Society of Sanitation Engineers (ASSE) for Valving Standards.
   7. American National Standards Institute (ANSI) for Piping Standards.
   8. NFPA Standard 51B - “Fire Prevention in Use of Cutting and Welding Processes”.
   9. Crosslinked polyethylene (PEX) pipe conforming to ASTM F876, F877 and CSA B1375, or DIN 16892 and 16893.

2.3 SANITARY, DRAINAGE (RAIN/STORM WATER) DWV PIPING, BURIED WITHIN 5-FEET OF BUILDING

A. ABS Pipe: ASTM D275 schedule 40 single extrusion or ASTM F628 Schedule 40, co extruded.
   1. Fittings: ABS DWV ASTM D2661.
   2. Joints: Solvent welded with ASTM D2235 cement.

## 2.4 SANITARY DWV PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM D2661 Schedule 40 single extrusion or ASTM F628 Schedule 40 coextruded.
   1. Fittings: ABS DWV ASTM D2661.
   2. Joints: Solvent welded with ASTM D2235 cement.

## 2.5 WATER PIPING, BURIED WITHIN 5-FEET OF BUILDING

A. Copper Pipe: ASTM B88, hard drawn, Type K (A).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
   2. Joints: Brazed - BCuP2.

B. Ductile Iron Pipe: AWWA C151/A21.51.
   1. Fittings: Ductile or gray iron, standard thickness.
   2. Joints: AWWA C111/A21.11, rubber gasket with 3/4-inch diameter rods.

## 2.6 HOT AND COLD WATER ABOVE GRADE

A. Copper Tube: 2-1/2-inches and smaller. ASTM B88 (ASTM B88M), Type L (B), Drawn.
   1. Fittings: ASME B16018 copper.
   2. Joints: ASTM B32, alloy Sn95 solder.

B. Copper Tube: Water pressures up to 250 PSI gauge. ASTM B 88 (ASTM BA 88m), Type K (A), Drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: Brazed BCuP2.

C. Cross-Linked Polyethylene Tubing, Fittings and Accessories (except exposed locations.)
   1. Tubing:
      a. Cross-linked polyethylene (PEX) tubing complies with requirements of ASTM F876 and F877, and cross-lining method must be Type A (hot)method.
      b. PEX tubing to have minimum working pressure of not less than 160 PSI for water at 73.4 degrees F, 100 PSI for water at 180 degrees F and 80 PSI for water at 200 degrees F determined in accordance with Plastic Pipe Institute Technical Report TR-3/92, and listed in Plastic Pipe Institute Technical Report TR-4/95.
   2. Fittings:
      a. Fittings: Brass Fittings above grade applications. Engineered plastic fittings below grade applications. Egnel type with reinforcement rings.
      b. Reinforcement Rings: Manufactured using "Engel Method" to ensure that viscoelastic stress regenerative properties are sufficient to produce pressure tight seal.
      c. Fitting Insert: Of such dimension in that tubing must be expanded in order to facilitate insertion of fitting into tube.
      d. Accomplish expansion of tubing and ring by an expansion tool designed expressly for that purpose.
      e. Fittings complies with requirements of ASTM F877.
   3. Manifolds: Provide premanufactured copper manifolds of same manufacturer as piping.
   4. Stubout Ells and Stubout Brackets: Provide premanufactured Type L copper stubout ells and copper stubout brackets.

## 2.7 CONDENSATE PIPING

A. Copper Tube: ASTM B 88 (ASTM B898M), Type L (B)
   1. Fittings: ASME B16.29, wrought copper.

2. Joints: ASTM B32, alloy Sn50 solder.

B. Piping for drainage of condensate from combustion fuel sources (such as condensing boilers and water heaters) is to be chemical resistant piping as noted in this section for area of application.

## 2.8 SUBSURFACE DRAIN PIPE BELOW GRADE

A. Corrugated polyethylene drainage tubing, perforated with maximum 1/8-inch wide slots. ADS, or approved equivalent.

## 2.9 PRIMER PIPING

A. Above Ground: Type L hard-drawn copper tubing with wrought sweat fittings and soldered joints.

B. Belowgound: Type L soft annealed copper tubing with wrought sweat fittings and brazed joints.

C. Belowgound: Cross-linked polyethylene (PEX) and engineered plastic fittings.

## 2.10 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3-inches and Under:
1. Ferrous Pipe: Class 150 malleable iron threaded unions.
2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1-Inch:
1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

## 2.11 DUCTILE IRON PIPE AND FITTINGS

A. Pipe: Class 52 ductile iron, ANSI A21.51, AWWA C1510-70, 10.34 bar cement lined; factory encased with 8 mil polyethylene tube or sheet.

B. Fittings: ANSI A21.10 mechanical joint, AWWA C110-1971, 17.24 bar. Fittings to be double field wrapped with 5cm, 20 mil vinyl tape, 50 percent overlap, Scotch Wrap No. 51.

C. Fittings restrained with 2000 PSI thrust blocks in accordance with NFPA-24.

## 2.12 ABS (ACRYLONITRILE - BUTADIENE - STYRENE) PIPE AND FITTINGS

A. Pipe and Pipe Fitting: Schedule 40 DWV, ASTM D2661-IAMPMO IS5-92. No foam core piping permitted.

B. Joints: Solvent weld, NSF 14-90, ASTM D2235-93A, ASTM F402-93.

2.13 CHEMICAL RESISTANT DWV PIPING

A. Polypropylene - Fire Retardant Pipe: All locations except plenums and rated assemblies. Polypropylene. ASTM F1412.
   1. Fittings: Polypropylene.
   2. Joints: Electrical resistance fusion. ASTM 1290.

2.14 WALL AND FLOOR SLEEVES

A. Below Grade and High Water Table Areas:
   1. "Link-Seal" Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Provide Type C unless otherwise noted. OS with S-316 stainless construction for continuous water/tank walls. Thunderline Corporation or approved equivalent.
   2. Sleeves under or through concrete foundations: Ductile iron pipe. Class 50 or 51 pipe conforming to ANSI/AWWA C151/A21.51, cement lined. Pipe sleeve will extend a minimum of 6-inches beyond outside perimeter of foundation. Final placement of sleeve will be confirmed with project's structural engineer. In areas with a high water table, provide AWWA C900, Class 235 plastic pipe in lieu of ductile iron pipe.

B. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.

C. Insulating Caulking: Eagle or Pitcher Super 66 high temperature cement.

D. Fabricated Accessories:
   1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
   2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide following minimum gauges for sizes indicated:
      a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.
      b. Sleeve Sizes 5-inches to 6-inches: 16 gauge.
      c. Sleeve Sizes 7-inches and Larger: 14 gauge.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

A. Work performed by experienced journeyman plumbers.

B. Provide access panels for concealed valves, shock arrestors and trap primers.

C. Install pipes and pipe fittings in accordance with recognized industry practices.

D. Align piping accurately at connections, within 3/32-inch misalignment tolerance. Comply with ANSI B31 Code for Pressure Piping.

E. Locate piping runs, as indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs

as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2-inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1-inch clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view by locating it in column enclosures, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

1. Do not run piping through transformer vaults, telephone, elevator, electrical or electronic equipment spaces or enclosures.
2. Concealed Piping Above Suspended Ceiling: Plan and coordinate to avoid interferences; install to maintain suspended ceiling heights shown on Architectural Drawings. Allow sufficient space above removable ceiling panels for panel removal. Locate piping so that valves are visible and accessible within 61cm horizontally and vertically from point of access to the ceiling space.
3. Exposed Work: Run pipes parallel to the closest wall unless otherwise shown on Drawings; maintain maximum headroom; avoid light fixtures.
4. Insulation Space Allowance: In piping work, allow space for pipe insulation and jackets. If interferences occur, move the piping to accommodate insulation thickness specified.
5. Pipe Lengths: Do not use short lengths or nipples at locations where a full length of pipe will fit.
6. Alignment Prior to Supporting and Anchoring: Place piping in proper alignment and position prior to connection to anchors, expansion loops, and equipment. Furnish jacking devices, temporary steel structural members, and assembled structures as necessary. Remove temporary equipment and structures supplied by contractor at completion; such items to remain Contractor property.
7. Valve and Equipment Connections: Piping not to place undue stress on flanged valves and equipment connections. Mating flange faces to be true and parallel to each other and not to require springing of piping for assembly. Pipe hangers and supports to carry the full weight of the pipe and fluid.
8. Piping Leaks: Correct immediately; use new materials; leak-sealing compounds or peening not permitted.
9. Pressure Ratings of Fittings, Valves, and Devices in Piping Systems: Pressure rating to be equal to or greater than the maximum working pressure of the system.
10. Equipment Vents and Drains: Provide for coils and vessels which contain water. Provide isolation valves and outlet valves at piping high and low points to permit venting and draining of the vessel without venting and draining connected piping. Provide hose connections and caps on drain lines.
11. Escutcheon Plates: Where exposed insulated and uninsulated piping passes through walls, floors or ceilings; provide spring clip type. Provide plates on both sides of wall or floor.

## 3.3 PIPE JOINTS

A. Piping to be cut squarely, free of rough edges and reamed to full bore. Piping to be fully inserted into fittings.

B. Provide joints of type indicated in each piping system.

C. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

D. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM std. B-32, in accordance with IAPMO Is 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints to be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes to be water soluble for copper and brass potable water applications, and meets CDA standard test method 1.0 and ASTM B813-91. Solder to be applied until a full fillet is present around the joint. Solder and flux not to be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosion flux not to be present at the jobsite.

E. Braze copper tube and fitting socket with BCUP series filler metal without flux. Listed brazing flux to be used for joining of copper tube to brass or bronze fittings and will meet AWS FB3A or FB3C. "Shock" cooling is prohibited. a continuous fillet is to be visible around the completed joint. After cooling, flux residue to be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10 percent nickel. Piping is to be capped or plugged during construction to prevent entry of foreign material.

F. Welders performing work under this Contract to be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation to conform to ANSI 31.1 "Power Piping".
   1. Submit for approval the names, identification, and welder's assigned number, letter or symbol for welders assigned to this project.
   2. The assigned identification symbol to be used to identify the work of each welder and to be indelibly stamped immediately upon completion of each weld.
   3. Welders to be tested and certified for all positions.
   4. Submit identifying stenciled test coupons made by each operator.
   5. Welders may be required to retake welding certification tests without additional expense.
   6. When so requested, a welder will not be permitted to work as a welder on this project until he has been recertified in accordance with NCWB.
   7. Recertification of the welder to be made after the welder has taken and passed the required tests.

G. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0F.
   2. Bevel pipe ends at a 37.5 degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   3. Use pipe clamps or tack-weld joints with 1-inch long welds, 4 welds for pipe sizes to 10-inches, 8 welds for pipe sizes 12-inches to 20-inches.
   4. Build up welds with a stringer-bead pass, followed by a hot pass, followed by a cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   5. Do not weld out piping system imperfections by tack-welding procedures. Re-fabricate to comply with requirements.
   6. At Installer's option, install forged branch-connection fittings whenever branch pipe is indicated, or install a regular T-fitting.

H. Flanges:
   1. Provide flanges at steel or copper piping, valves and equipment, sizes 2-1/2-inches or larger, unless specified otherwise; weld neck or slip-on pattern.
   2. Bolts: Provide studs (both ends threaded) with hexagon nuts where necessary to facilitate removal of valves or disassembly of flanged systems.
   3. Dielectric Flanged Insulation: Provide on dissimilar metal flanged piping connections.

## 3.4 SANITARY AND STORM SEWER

A. Piping to be graded at a uniform pitch of 1 percent per foot on building main and 2 percent per foot on branch lines unless otherwise noted on Drawings.

B. Indirect Waste or Drain Piping: Extend piping to discharge as shown on Drawings. Maintain minimum air gap. Provide traps on direct waste or drain piping exceeding 60-inches.

C. Fixture Carriers: Concealed fixture carriers for wall hung plumbing fixtures are specified in Section 22 40 00.

D. Drains:
   1. Install drains to suit finished floor or roof surface. Install drains and components per manufacturer's instructions. Arrange for flooring to be sloped to floor drain or sink a minimum of 13mm below finished floor elevation.
   2. Install P-traps for hub drains, floor drains and floor sinks P-traps to be of the same materials as soil and waste piping. Provide trap primer assembly for each drain or floor sink.

E. Wall Access Panel: Secure to wall framing and install so that flange forms a close fitting joint with the finished wall surface.

F. Heat trace and insulate P-traps exposed to freezing conditions.

G. Insulate horizontal interior rainwater drain and storm drain lines.

H. Insulate horizontal branch lines from floor sinks, recepters and drains receiving cold discharge from equipment and appliances.

## 3.5 DOMESTIC WATER

A. "Piping" to include pipes, fittings, nipples, valves and accessories connected thereto.

B. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts, flues, conduits and work of other trades, and as close to ceiling or other construction as practical, free of unnecessary traps or bends.

C. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.

D. Piping connections to equipment to be made up with unions.

E. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.

F. Use reducers or increasers. Use no bushings.

G. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageways.

H. Cover, cap or otherwise protect open ends of piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect and sterilize water supply piping as specified. Furnish written report on final water quality results.

I. Exposed connections to equipment to be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bent piping to be permitted.

J. Ferrous to non-ferrous connections to be made by means of dielectric fittings.

K. Use extra heavy pipe for nipples, where unthreaded portion is less than 1-1/2-inches. Use no close nipples. Use only shoulder-type nipples.

L. Through-Wall Pipes: Type 'L' copper tubing for through-wall pipes which connect to exposed stops at wall surface. Anchor the pipes in the wall; attach pipe with U-bolts to steel back-up plates or steel angles anchored in the wall. Provide wrought copper elbow which securely anchors ears in wall at through-wall pipes.

M. Provide drain valves at base of risers and at low points on the system.

N. Backflow Preventers: Pipe relief to nearest drain. Slope at 2 percent per foot.

## 3.6 CHEMICAL RESISTANT DWV PIPING

A. Installation Guidelines for polypropylene pipe:
   1. Install hangers and supports at intervals specified in the applicable Plumbing Code and as recommended by pipe manufacturer.
   2. Support vertical piping at each floor and as specified in the applicable Plumbing Code.
   3. Fusion Welding of Joints:
      a. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting type. Fusion-well joints to be made in accordance with the pipe and fitting manufacturer's Specifications and product standards.
      b. Fusion-weld tooling, welding machines, and electrofusion devices to be as specified by the pipe and fittings manufacturer.
      c. Prior to joining, the pipe and fittings to be prepared in accordance with F 2389 and the manufacturer's Specifications.
      d. Joint preparation, setting and alignment, fusion process, cooling times and working pressure to be in accordance with manufacturer's installation guidelines.

## 3.7 SLEEVES

A. Pipe Sleeves:
   1. Layout work in advance of pouring concrete, furnish, and set sleeves necessary to complete work.
   2. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor. Caulk pipes passing through floor with non-shrinking grout or approved caulking compound (Except DWV Piping penetrating a concrete Slab set on Finish Grade), provide "Link-Seal" sleeve sealing system for concrete/slab penetrations which are below grade. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements
   3. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with non-shrinking caulking compound. Provide "Link-Seal" sleeve sealing system for concrete penetrations which are below grade. Caulk/seal piping passing through fire-rated assemblies per local AHJ requirements.
   4. Beam Sleeves: Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Indicate penetrations on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Plumbing Drawings are diagrammatic. Offset piping as required to meet these limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed

for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.

B. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
   1. Install fabricated pipe sleeve.
   2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D.
   3. Seal each end airtight with a resilient nonhardening seal per code.

C. Piping penetrations through fire-rated (1 to 3 hour) assemblies:
   1. Select and install pre-engineered pipe penetration system in accordance with UL listing and manufacturer's recommendation.
   2. Reference Division 7.
   3. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E84.

## 3.8 EXCAVATION AND BACKFILL

A. Trenching, bedding and backfill to meet the requirements of the Project Geotechnical Report. The standards listed below are a minimum.

B. Native soils may not be used for bedding or pipe zone backfill without specific approval of the Project Geotechnical Consultant.

C. General: Perform necessary excavation and backfill required for installation of plumbing work. Repair piping or other work at no expense to Owner.

D. Water: Keep excavations free of standing water. Reexcavate and fill back excavations damaged or softened by water or frost to original level with sand, crushed rock or other approved material at no expense to Owner.

E. Tests: During progress of work for compacted fill, Owner reserves right to request compaction tests made under direction of testing laboratory.

F. Trench Excavation: Excavate trenches to necessary depth and width, removing rocks, unstable soil (muck, peat), roots and stumps. Excavation material is classified as "base fill" and "native." Base fill excavation material consisting of placed crushed rock may be used as backfill above "Pipe Zone." Remove and dispose off site native excavation material. Adequate width of trench for proper installation of piping or conduit.

G. Support Foundations:
   1. Foundations: Excavate trenches located in unstable ground areas below elevation required for installation of piping to depth which is determined by Architect as appropriate for conditions encountered. Place and compact approved foundation material in excavation up to "Bedding Zone." Dewatering, placement, compaction and disposal of excavated materials to conform to requirements contained in other sections of Specifications or Drawings.
   2. Over-Excavations: Where trench excavation exceeds required depths, provide, place and compact suitable bedding material to proper grade or elevation at no additional cost to Owner.
   3. Foundation Material: Where native material has been removed, place and compact necessary foundation material to form base for replacement of required thickness of bedding material.

| | Class A | | Class B | |
|---|---|---|---|---|
| Material Passing | Min. | Max. | Min. | Max. |
| 3/4-inch Square Opening | 27 | 47 | 0 | 1 |

4. Bedding Material: Full bed piping on sand, pea gravel, or 3/4-inch minus crushed rock. Place minimum 4-inch deep layer of sand, pea gravel, or crushed rock on leveled trench bottom for this purpose. Remove bedding to necessary depth for piping bells and couplings to maintain contact of pipe on bedding for its entire length. Provide additional bedding in excessively wet, unstable, or solid rock trench bottom conditions as required to provide firm foundation.

H. Backfilling:
   1. Following installation and successful completion of required tests, backfill piping in lifts.
      a. In "Pipe Zone" place backfill material and compact in lifts not to exceed 6-inches in depth to height of 12-inches above top of pipe. Place backfill material to obtain contact with entire periphery of pipe, without disturbing or displacing pipe.
      b. Place and compact backfill above "Pipe Zone" in layers not to exceed 12-inches in depth.
   2. Backfill Material:
      a. Backfill Material in "Pipe Zone": 3/4-inch minus crushed rock, sand or pea gravel.
      b. Crushed rock, fill sand or other backfill material approved elsewhere in Specifications may be used above "Pipe Zone."

I. Compaction of Trench Backfill:
   1. Where compaction of trench backfill material is required, use one of following methods or combination thereof:
      a. Mechanical tamper,
      b. Vibratory compactor, or
      c. Other approved methods appropriate to conditions encountered.
   2. Architect to have right to change methods and limits to better accommodate field conditions. Compaction sufficient to attain 95 percent of maximum density at optimum moisture content unless noted otherwise on Drawings or elsewhere in Specifications. Water "puddling" or "washing" is prohibited.

## 3.9 TESTING

A. General:
   1. Provide temporary equipment for testing, including pumps, compressors, tanks, and gauges, as required. Test piping systems before insulation (if any) is installed and remove or disengage control devices before testing. Where necessary, test sections of each piping system independently, but do not use piping valves to isolate sections where test pressures exceed local valve operating pressure rating. Fill each section with water, compressed air, or nitrogen and pressurize for the indicated pressure and time.
   2. Notify Architect and local Plumbing Inspector 2 days before tests.
   3. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in sections if minimum head cannot be maintained in each section. 5 PSI head to be minimum pressure at highest joint.

4. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.
5. Send test results to Architect for review and approval.

B. Testing of Pressurized Systems:
1. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
2. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.

C. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at hydrostatic pressure of 125 PSIG.

## 3.10 STERILIZATION OF DOMESTIC WATER SYSTEM

A. General: Upon completion of tests and necessary replacements, thoroughly flush and disinfect domestic water piping.

B. Method: After thoroughly flushing system with water to remove sediment, fill system with a solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 3 hours. After retention, drain, reflush and return system to service.

C. Certification: Provide copy of domestic water chlorination certificate in each operations and maintenance manual.

## 3.11 PROTECTION

A. Keep pipe openings closed by means of plugs or caps to prevent entrance of foreign matter. Protect piping, ductwork, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore to its original condition or replace fixtures, equipment or apparatus damaged prior to final acceptance of work.

## 3.12 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Reference Division 7.

B. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

C. Manufacturers: Hilti and Proset.

## 3.13 BURIED PREINSULATED PIPE INSTALLATION

A. Installation and Testing: Install and test products in accordance with manufacturer’s installation instructions.

B. Manufacturer’s installation instructions shall describe the following:
1. Storage and handling of pipes.
2. Trench preparation.
3. Installing pipe.

4. Installing accessories.
5. Installing fittings.
6. Building penetrations.
7. Field insulation kits.
8. Testing.

END OF SECTION

# SECTION 22 11 23.13 – Domestic Water Booster Pumps

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

A. Skid- Mounted Pumping Package

B. Integral Drive Controller (IDC)

C. Variable Frequency Drive (VFD)

D. Sensors/Transmitters

E. Sequence of Operation

### 1.2 DESIGN CRITERIA

A. The drawings indicate sizes, profiles, connections and dimensional requirements of plumbing pumps and based on the specific manufacturer types and models indicated.

B. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design intent and performance.

### 1.3 TESTING & APPROVING AGENCIES

A. Where items of equipment are required to be provided with compliance to U.L., C.S.A., E.T.L., or other testing and approving agencies, the contractor may submit a written certification from any nationally recognized testing agency, adequately equipped and competent to perform such services, that the item of equipment has been tested and conforms to the same method of test as the listed agency would conduct.

### 1.4 SUBMITTAL DATA

A. Provide manufacturer's literature for all products specified in this Section, which will be installed under this project.

B. Provide performance curves for all pumps. Plot the specified operating point for each pump on its respective curve.

C. Provide complete literature for all components of packaged systems. These include pump performance, data for all accessories and valves and complete wiring diagrams specific to the exact unit to be supplied. The wiring diagram shall indicate all required field and factory wiring.

PART 2 - PRODUCTS

A. Domestic Water Booster System

1. Pumps shall be Taco Model VM or approved equal. The pumps shall be vertical inline multi- stage design. The capacities and characteristics shall be as called for in the plans/schedules.
   Pump outer casing shall be 316 Stainless Steel with piping connections either Victaulic® or ANSI flanges rated for 300 psi.
   Pump shall have type 316 Stainless Steel wetted parts.
2. Each impeller shall be fitted with a Teflon seal ring.
3. The mechanical seal shall be suitable for the full pressure and temperature range of the pump and shall be fitted with carbon rotating face and silicon carbide stationary face.
4. The thrust bearing must be connected to the adaptor and shaft coupling in such manner as to eliminate pump thrust loads from the motor, allowing standard NEMA “TC” frame design motors to be used.
5. The suction and discharge headers shall be made of 304 stainless steel.
6. The system shall include mainly the pump & motor assemblies on a common structural steel base, integral control rack, VFD (‘s) and integrated VFD controller (IDC), electrical connection enclosure, suction and discharge piping & headers.
7. The system shall include stainless steel suction & discharge ball valves, and non-slam check valve on the discharge. They shall be plumbed together using a grooved mechanical pipe joining system.
8. The discharge of each pump shall be fitted with a check valve. Each pump and discharge valve assembly shall also be equipped with isolation valves so that the pump can be serviced.
9. One 0-10Vdc single point pressure sensor, 0-200 PSI range, mounted on discharge header to be used to properly execute the sequence of operation.
10. The system shall require only suction and discharge connections and a single point power connection.
11. All components shall be mounted on a structural steel base suitable for grouting.
12. Pressure gauges shall be installed on the suction and discharge headers.

B. Integrated Drive Controller

1. The pump system controller (IDC) shall be integrated with each variable frequency drive as one unit.
2. The controller shall be microprocessor based capable of access via personal computer to facilitate software changes and updates. The controller shall have a fully graphic, multilingual display with a large, bright, backlit graphic display to provide complete drive information.
3. The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.
4. The controller shall display the following as status readings from a single display on the controller
   (i) Current value of the control parameter.
   (ii) Most recent existing alarm (if any).
   (iii) System status with current operating mode.
   (iv) Status of each pump with current operating mode and rotational speed as a percentage.
5. The controller shall have as a minimum the following hardware inputs and outputs:
   (i) 2 Analog Inputs (4-20mA or 0-5Vdc or 0-10Vdc).
   (ii) 6 Digital Inputs (Programmable and 2 can be used as outputs).
   (iii) 1 Analog Output (Programmable).
   (iv) 2 Standard Form C 240V Relay.
   (v) Ethernet connection.

(vi) Field Service connection to PC.

6. All analog inputs shall be provided with current limit circuitry to provide short circuit protection and safeguard against incorrect wiring of sensors.
7. Pump system programming shall include the following protections:
   (i) Ground Fault
   (ii) Motor stall
   (iii) Motor over temperature
   (iv) Motor compensation & overload
   (v) Pump no-flow
   (vi) Dry Pump
   (vii) Fault Tolerant Control
   (viii) Pump end of curve
   (ix) Short-cycle
8. The controller shall be capable of receiving a remote analog set point (0-5V, and 0-10V).
9. No flow shutdown shall not require any external flow meters or flow switches or pressure switches to determine when a NO FLOW condition exists.
10. The controller shall be compatible with the following communication protocols via the RS-485 port:
    (i) Johnson Controls Metasys (N2)
    (ii) Siemens Building technologies system 600 (FLN)
    (iii) BACnet, FC Protocol
    (iv) Modbus RTU systems

C. Variable Frequency Drive (VFD)

1. The VFD shall convert incoming fixed frequency single – phase or three phase AC power into a variable frequency and voltage for controlling the speed of the three phases AC induction motors.
2. The VFD shall be a six-pulse input design, and the input voltage rectifier shall employ a full wave diode bridge; VFD's utilizing controlled SCR rectifiers shall not be acceptable. The output waveform shall closely approximate a sine wave. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.
3. The VFD shall be in a NEMA 1, 12 & 4X enclosures with mechanical, electrical disconnect.
4. The VFD will be mounted on the control rack utilizing vibration isolating gromets capable of reducing the system vibration transmission to the VFD
5. The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor.
6. The VFD shall be able to provide its full rated output current continuously at 110% of rated current for 60 seconds.
7. Automatic motor adaptation (AMA) algorithm shall be utilized. This feature shall allow for automatically optimized drive performance and efficiency leading to additional energy savings.
8. The VFD shall provide full torque to the motor given input voltage fluctuations of up to +10% to 15% of the rated input voltage.
9. The VFD shall be suitable for elevations to 3300 feet above sea level without derating. Maximum operating ambient temperature shall not be less than 104 degrees ˚F VFD shall be suitable for operation in environments up to 95% non-condensing humidity.
10. The VFD shall be capable of displaying the following information in plain English via a 40-Character alphanumeric display:
    (i) Frequency
    (ii) Voltage
    (iii) Current
    (iv) Actual System Set point
    (v) Actual System Demand

(vi) Kilowatts per hour
(vii) Fault identification
(viii) Percent torque
(ix) Percent power
(x) RPM

D. Electrical Connection
1. The main electrical connection shall be made through a single NEMA 4 steel enclosure with a hinged gasketed door.
a. The enclosure will contain the terminals to split the incoming power to each drive.
b. The enclosure shall be U.L. labeled, and factory prewired

E. Sensor/Transmitters
1. Provide header mounted 0-200 PSI single point pressure sensor transmitter(s) as indicated on the plans. Unit shall transmit an isolated 0-5V or 0-10V DC signal indicative of process variable to the integrated drive controller via standard two wire 24VDC system.
2. Unit shall have stainless steel wetted parts and a ceramic diaphragm with one ¼" male NPT process connection.
3. A pressure snubber shall be required to protect against any water hammering. Accuracy shall be within 0.25% of full span.
4. A certification of final calibration shall be required for each sensor/transmitter.
5. Provide low and high pressure switches with adjustable setpoints at suction & discharge headers. Suction pressure switch range 3.0 – 150 PSIG, and discharge pressure switch range 5.0 – 250 PSIG.
6. Provide thermal relief assembly, reverse acting thermostatic water valve, for overtemperature protection.

F. Sequence of Operation
1. The IDC shall compare the sensor signal to the independent DCC representative determined set point
2. When all the point is satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.
3. The IDC shall continuously scan and compare the process variable to the set point and control to satisfy the set point.
4. If the set point cannot be satisfied by the designated lead pump, the IDC shall initiate a timed sequence of operation to stage a lag pump.
5. The lag pump shall accelerate resulting in the lead pump decelerating until they equalize in speed.
6. Further change in process variable shall cause the pumps to change speed together.
7. No-Flow Detection:
(i) In addition to staging a pump off when it is running at minimum frequency, the VFD can also monitor the power provided to the motor by the drive. If this power is low for the operating speed, a no-flow condition is indicated.
(ii) The no-flow power level for each drive/pump combination can be easily determined by using an automated macro during system start-up. If a drive's output power for its operating speed indicates a no-flow condition and the No-Flow Delay timer expires, the drive will enter a sleep condition and turn off.
8. End-Of-Curve Detection:
(i) End-of-curve detection is meant to detect a situation where a broken pipe causes one or more pumps to run at full speed and create excessive flow without reaching the set point pressure, the LEAD drive will issue a warning to indicate this.
9. Dry Pump Protection:
(i) This feature is used to detect if a pump has run dry, such as improper system

fill at start up or when a pump has been out of service and restarted without water. This condition can cause pump damage if not detected and corrected promptly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps in accordance with manufacturer's requirements.

B. Provide drains for bases and stuffing boxes piped to and discharging into floor drains

C. Support piping adjacent to pump such that no weight is carried on pump casings.

D. Support suction guide and discharge elbow from a floor stand with rubber and shear sandwich pad isolators or from above with hangers and spring isolators

E. Check motor and pump lubrication points, fill oil reservoir on in-inline of pumps

F. Provide vibration isolated pipe hangers (resilient support) next to pumps on piping.

G. Field connection to BACnet interface is by controls contractor.

H. Thermal relief piped to drain by contractor.

3.2 FIELD QUALITY CONTROL

A. Test pumps and systems to verify capacity, sequence of operation and flow.

3.3 START-UP AND TRAINING

A. Manufacturer's representative to review and approve installation.

B. Manufacturer's representative to participate in start-up of domestic water booster systems.

C. Manufacturer's representative to provide operator training in the operation, maintenance and adjustment of the domestic water booster systems.

3.4 PERFORMANCE

A. Refer to pump schedule.

END OF SECTION 22 11 23.13

# SECTION 223300 - ELECTRIC, DOMESTIC WATER HEATERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes the following for domestic water systems:

1. Electric water heaters.
2. Tankless, electric water heaters.
3. Commercial, electric water heaters.
4. Compression tanks.
5. Accessories.

### 1.3 SUBMITTALS

A. Product Data: For each type and size of water heater. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Shop Drawings: Detail water heater assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Product Certificates: Signed by manufacturers of water heaters certifying that products furnished comply with requirements.

D. Maintenance Data: For water heaters to include in maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.

### 1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on specific units indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 1.

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

D. ASME Compliance: Fabricate and label water heater, hot-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

E. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:

1. ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," for commercial water heaters.
2. ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings," for household water heaters.

## 1.5 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include heating elements, storage tanks.
2. Warranty Period: From date of Substantial Completion:

a. Heating Elements: Three (3) years.
b. Storage Tanks: Five (5) years.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

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

1. Household, Point-of-Use, Storage, Electric Water Heaters:

a. Bradford White Corp.
b. Lochinvar Corp.
c. Rheem Manufacturing Co.; Rheem Water Heater Div.
d. Rheem Manufacturing Co.; Ruud Water Heater Div.
e. Smith: A.O. Smith Water Projects Co.
f. State Industries.

2. Point-of-Use, Tankless, Electric Water Heaters:

a. Eemax, Inc.

2. Commercial, Storage, Electric Water Heaters:

a. Bradford White Corp.
b. Lochinvar Corp.
d. PVI Industries, Inc.
e. Rheem Manufacturing Co.; Rheem Water Heater Div.
f. Rheem Manufacturing Co.; Ruud Water Heater Div.
g. Smith: A. O. Smith Water Products Co.
h. State Industries.

3. Compression Tanks:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Myers: F. E. Myers.
d. Smith: A. O. Smith; Aqua-Air Div.
e. State Industries.
f. Taco, Inc.
g. Wessels Co.
h. Zurn Industries, Inc.; Wilkins Div.

## 2.2 STORAGE, ELECTRIC WATER HEATERS

A. Description: Comply with UL 174.

B. Storage Tank Construction: Steel with 150-psig (1035-kPa) working-pressure rating.

1. Tappings: Factory fabricated of materials compatible with tank for piping connections, relief valve, drain, anode rod, and controls as required. Attach tappings to tank before testing and labeling. Include ASME B1.20.1, pipe thread.

2. Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

3. Insulation: Comply with ASHRAE 90.2. Surround entire storage tank except connections and controls.

4. Jacket: Steel, with enameled finish.

C. Heating Elements: Two electric, screw-in, immersion type.

1. Temperature Control: Adjustable thermostat for each element. Include wiring arrangement for nonsimultaneous operation.

D. Anode Rod: Factory installed, magnesium.

E. Drain Valve: ASSE 1005, factory installed.

## 2.3 POINT-OF-USE, TANKLESS, ELECTRIC WATER HEATERS

A. Description: Comply with UL 499.

B. Construction: Without hot-water storage.

1. Working-Pressure Rating: 125 psig minimum.
2. Tappings: ASME B1.20.1, pipe thread.
3. Interior Finish: Materials complying with NSF 61, barrier materials for potable-water tank linings.
4. Jacket: Aluminum or steel, with enameled finish, or plastic.

C. Heating System: Electric-resistance type.

1. Temperature Control: Adjustable thermostat.
2. Temperature Control: Flow-control fitting in inlet piping.
3. Safety Control: Automatic, high-temperature-limit cutoff device or system.
4. Integral thermostatic mixing valve: ASSE 1070, factory set.

D. Mounting: Bracket or device for wall mounting.

2.4 COMMERCIAL, STORAGE, ELECTRIC WATER HEATERS

A. Description: Comply with UL 1453.

B. Storage Tank Construction: ASME-code steel with 150-psig (1035-kPa) working-pressure rating.

1. Tappings: Factory fabricated of materials compatible with tank for piping connections, relief valve, pressure gage, thermometer, drain, anode rods, and controls as required. Attach tappings to tank shell before testing and labeling.

a. NPS 2 (DN50) and Smaller: Threaded ends according to ASME B1.20.1, pipe threads.
b. NPS 2-1/2 (DN65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

2. Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
3. Insulation: Comply with ASHRAE 90.1. Surround entire storage tank except connections and controls.
4. Jacket: Steel, with enameled finish.

C. Heating Elements: Electric, screw-in or bolt-on, immersion type arranged in multiples of three.

1. Temperature Control: Adjustable, surface-mounted thermostat.
2. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

D. Drain Valve: ASSE 1005, corrosion-resistant metal, factory installed.

E. Anode Rods: Factory installed, magnesium.

F. Dip Tube: Factory installed. Not required if cold-water inlet is near bottom of storage tank.

G. Special Requirement: NSF 5 construction.

2.5 COMPRESSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

B. Construction: 150-psig (1035-kPa) working-pressure rating.

C. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.

D. Tank Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

E. Tank Exterior Finish: Manufacturer's standard, unless finish is indicated.

F. Air-Charging Valve: Factory installed.

## 2.6 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.

B. Water Heater Stands: Water heater manufacturer's factory-fabricated, steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches (457 mm) above the floor.

C. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated, steel bracket for wall mounting and capable of supporting water heater and water.

D. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4 (DN20).

# PART 3 - EXECUTION

## 3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated. Refer to Division 3 and Division 15 Section "Basic Mechanical Materials and Methods."

## 3.2 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.

1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.

B. Install water heaters, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Anchor water heaters to substrate.

D. Install temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.

E. Install water heater drain piping as indirect waste to spill into open drains or over floor drains. Refer to Division 15 Section "Plumbing Specialties" for drain valves.

F. Install thermometers on water heater inlet and outlet piping. Refer to Division 15 Section "Meters and Gages" for thermometers.

G. Install pressure gages on water heater piping. Refer to Division 15 Section "Meters and Gages" for pressure gages.

H. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

I. Fill water heaters with water.

J. Charge compression tanks with air.

## 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union.

D. Make connections with dielectric fittings where piping is made of dissimilar metal and at water heaters.

E. Electrical Connections: Power wiring and disconnect switches are specified in Division 16 Sections. Arrange wiring to allow unit service.

F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

## 3.4 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform startup service.

B. In addition to manufacturer's written installation and startup checks, perform the following:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify that piping system tests are complete.
3. Check for piping connection leaks.
4. Check for clear relief valve inlets, outlets, and drain piping.
5. Check operation of circulators.
6. Test operation of safety controls, relief valves, and devices.

7. Energize electric circuits.
8. Adjust operating controls.
9. Adjust hot-water-outlet temperature settings. Do not set above 140 deg F (60 deg C) unless piping system application requires higher temperature.
10. Balance water flow through manifolds of multiple-unit installations.

## 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water heaters.

1. Train Owner's maintenance personnel on procedures for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals. Refer to Division 1.
3. Review data in maintenance manuals. Refer to Division 1.
4. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 223300

# 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

### 1.3 SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

G. Warranty: Sample of special warranty.

### 1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA 90.1 Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:
   1. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

## 1.5 COORDINATION

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

## 1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Periods: From date of Substantial Completion.
      a. Commercial, Domestic-Water Heaters:
         1) Storage Tank and Heat Exchanger: Manufacturers standard.
         2) Controls and Other Components: Manufacturers standard.
         3) Separate Hot-Water Storage Tanks: Manufacturers standard.
      b. Compression Tanks: Five years.

# PART 2 - PRODUCTS

## 2.1 COMMERCIAL, DOMESTIC-WATER HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Manufacturers:
      a. Bradford White Corporation.
      b. Laars.
      c. Lochinvar Corporation.
      d. Rheem/Ruud Manufacturing Company.
      e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
      f. State Industries Corporation.

B. Commercial, Ultra-High Efficiency, Gas Water Heaters: Comply with ANSI Z21.10.3 for gas-water heaters.
   1. Description: Self-contained condensing water heater with combustion chamber, storage tank, piping, and controls.
   2. Construction: 150-psig working-pressure rating; 300-psig test pressure.
   3.
      a. Heat Exchanger: All welded, stainless steel; Gasketless.
      b. Connections: Factory fabricated of materials compatible with heater.
         1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
         2)
   4. Minimum 95.0% thermal efficiency.
   5. Tank: Vitraglas vitreous enamel.
      a. Hand hole cleanout.

b. Four extruded magnesium anode rods installed in separate head couplings.
c. Insulation: Non-CFC foam. Comply with ASHRAE/IESNA 90.1. Surround entire tank except connections and controls.
d. Jacket: Steel with enameled finish.
e. Self Compensating Combustion System
f. Double igniter, Low NOx operation, sealed combustion; natural-gas fuel.
g. Stainless steel baffles.
h. Direct-Vent; PVC sidewall vent connections.
i. ASME temperature and pressure relief valve.
j. Condensate trap.
k. Zero clearances to combustibles.

6. Controls: Front mounted.
   a. Digital LCD display.
   b. Adjustable, electronic thermostat to any temperature up to 180deg F.
   c. Safety Control: Automatic, high-temperature-limit cutoff device or system.
   d.
7. Minimum Vent Diameter: Min. 3 inch PVC or CPVC vent and min. 3 inch PVC or CPVC combustion air.
8. Refer to construction drawings for detail and schedule of capacities and characteristics.

## 2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL Inc.
   b. Honeywell International Inc.
   c. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   d. State Industries.
   e. Taco, Inc.
   f. Watts.
   g. Wessels.
   h. Zurn Industries.
2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.
4. Capacity and Characteristics:
   a. Working-Pressure Rating: 150 psig.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.

F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

H. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

## 2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

# PART 3 - EXECUTION

## 3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03 Section.
1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.

2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Division 23 Section "Facility Natural-Gas Piping."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

G. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

H. Fill domestic-water heaters with water.

I. Charge domestic-water compression tanks with air.

## 3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Division 23 Section "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

## 3.3 IDENTIFICATION

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

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

## 3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION 223400

# SECTION 22 40 00 - PLUMBING FIXTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Work Included: Provision of materials, installation and testing of plumbing fixtures and drain.
   1. General Plumbing Fixtures
   2. Emergency Showers/Eyewash
   3. Fixture Trim
   4. Floor Drains
   5. Floor Sinks
   6. Roof/Overflow Drains

### 1.2 RELATED SECTIONS

A. Contents of Division 22 and Division 01, General Requirements apply to this section.

### 1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00 and Division 01, General Requirements.

### 1.4 SUBMITTALS

A. Submittals as required by Section 22 00 00 and Division 01, General Requirements.

### 1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, meet the following:
   1. Comply with lead free (less than or equal to 0.25 percent) products in drinking water systems.
   2. NSF 61 Appendix 'G' Compliant.
   3. ISO 9001 Certified.
   4. IAPMO Low Lead Certification

### 1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, provide:
   1. Faucets: Provide five year extended warranty.
   2. Flush Valves: Provide three year extended warranty.

PART 2 PRODUCTS

## 2.1 MANUFACTURERS

A. Manufacturers as specified in individual articles below or approved equivalent.

## 2.2 GENERAL PLUMBING FIXTURES

A. Architect will review any substitution request prior to bid submittal. Substitutions after bid to be considered as a deductive alternative only.

B. Fixtures, faucets and accessories to meet barrier free requirements of governing code.

C. Items approved for use by State of Oregon.

D. Reference architectural details for mounting heights of fixtures.

E. Provide factory fabricated fixtures of type, style and material indicated on the plumbing fixture connection schedule on drawings. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by manufacturer, and as required for complete installation. Where more than one type is indicated, selection is installer's option; but, fixtures of same type must be furnished by a single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

F. Fixtures provided complete with fittings, supports, fastening devices, bolt caps, faucets, valves, traps, stops and appurtenances.

G. Plumbing Fixtures Flow Rates:
   1. Sinks to be set for 1.0 GPM flow max.

H. Stainless Steel Fixtures:
   1. Sinks: Type 302, 18 gauge with "U" channel mounting systems by Elkay, Just, Kohler, Kindred or Advanced TABCO.
   2. Fixtures Subject to Corrosion: Type 316 stainless steel.
   3. Foundary Items: Commercial grade, heavy duty, no plastic by Josam, J.R. Smith, Neenah, Wade, Watts or Zurn.
   4. Emergency Eye Wash/Showers: Encon, Bradley, Haws, Chicago, Guardian or Speakman.
   5. Faucets: Lead Free by Chicago, Delta Commercial, KWC, Grohe, T & S Brass, American Standard, Kohler or Wolverine Brass.
   6. Fixture Trim: Lead Free by American Standard, Chicago, Kohler, McQuire Elkay, Just or Zurn.

## 2.3 EMERGENCY SHOWERS/EYEWASH

A. Compliant with ANSI Z 358.1.

B. ES-1: Emergency Shower at Door:
   1. Fixture: Speakman SE 238-SR, 20 GPM at 30 PSI, 1 1/4-inch inlet.
   2. Mixing Valve: Speakman SE-364-RC, mixing valve in recessed cabinet, 85 degrees F delivery.

C. EW-1: Eye Wash at Sinks:

1. Fixture: Speakman SE-570, 3 GPM at 30 PSI, mount on right hand side of sink unit, 1/2-inch inlet.
2. Mixing valve: Speakman SE-370, mount under sink unit, 1/2-inch inlets, 85 degrees F delivery.

## 2.4 FIXTURE TRIM

A. Traps: Provide heavy duty commercial grade traps on fixtures except fixtures with integral traps. Exposed traps will be chromium plated cast brass or 17 gauge chromium plated brass tubing.
   1. Sink: McGuire 8912-C-DF.
   2. Lavatory: McGuire 890-2-C-DF.

B. Supplies and Stops: Lead free heavy duty commercial grade, chrome plated with brass stems. Stops: Loose key type.
   1. Lavatory: McGuire LFH 2165 LK.
   2. Sink: McGuire LFH 2167 LK.

C. Grid strainer: McGuire 155A.

D. Sink strainer: McQuire 152N.

E. Trim barrier-free wrap for P-traps and supplies by McGuire, Pro-Wrap, Brocar or True-bro.

## 2.5 FLOOR DRAINS

A. Epoxy coated cast iron body with flange, clamp collar, seepage openings, bottom outlet; caulk inside, Ty-seal or no-hub joint.

B. FD-1: Finished Area Floor Drain: Zurn series Z/S-415-6B-P-IC(NH), (JR Smith 2005-Y-A06-NB-P) 6-inch diameter stainless steel strainer top, trap primer.

C. FD-2: Unfinished Area or Mechanical Room Floor Drain, Zurn series Z-520-DG-P-Y-IC(NH), (JR Smith 3220-M-P-B) 9-inch diameter adjustable ductile iron grate with sediment bucket, trap primer.

D. FD-4: Finished Area Shower Drain: Zurn FD-2254-NH2-R5 (JR Smith 220-C02-10) cast iron body, adjustable 5-inch diameter nickel strainer, beveled clamping collar, chrome plated finish.

## 2.6 FLOOR SINKS

A. White epoxy coated cast iron body with seepage flange, acid resistant interior surfaces aluminum dome strainer, bottom outlet, caulk inside, Ty-Seal or No-Hub joint. Provide trap primer.

B. FS-1: Floor Sink, 12-inches x 12-inches x 8-inches, no grate, CECO 908-1. (JR Smith 330-Y)

## 2.7 ROOF/OVERFLOW DRAINS

A. Drains: Epoxy coated cast iron body with flange, flashing ring with gravel stop, under deck clamp, extension, sump receiver, caulk inside, Ty-seal or no-hub joint.
   1. RD-2: Small Area Roof Drain: Zurn series ZA-125-C-E-R, (JR Smith 1330-AD-C-E-R) 7 1/2-inches aluminum dome, 8 3/8-inches cast iron body.

2. OD-2: Small Area Overflow Drain: Zurn ZA-125-C-E-R-89, (JR Smith 1330-AD-C-E-R-WD02) 2-inch water dam.

## PART 3 EXECUTION

### 3.1 VERIFICATION OF CONDITIONS

A. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

C. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.

D. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, original design, and referenced standards.

E. Comply with barrier free installation requirements of governing code with respect to plumbing fixtures provided for physically handicapped.

F. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

G. Install a stop valve in an accessible location in water connection to each fixture.

H. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

I. Seal fixtures to walls and floors using silicone sealant Dow Corning No. 780 or approved equivalent. Match sealant color to fixture color.

J. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

K. Inspect each installed unit for damage. Replace damaged fixtures.

L. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream.

M. Replace washers or cartridges of leaking or dripping faucets and stops.

N. Clean fixtures, trim and strainers using manufacturer's recommended cleaning methods and materials.

O. During construction cover installed fixtures, drains, sinks, and water coolers with cardboard boxes and wrap with Visqueen.

P. Provide trap primers for floor drains, floor sinks and hub drains.

Q. Roof and overflow roof drains installed per architectural details. Drains covered during roof construction to protect drain and off set supply piping.

R. Lead flashing not to be used.

## 3.2 OWNER-FURNISHED EQUIPMENT

A. Rough-in and make final connections to Owner furnished equipment. Provide necessary items to complete installation.

B. Comply with requirements of this Section and Drawings for installation procedures.

C. Reference Plumbing Fixture Connection Schedule on Drawings.

## 3.3 ADJUSTING AND CLEANING

A. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation. Adjust water pressure at drinking fountains, faucets, shower valves and flush valves to provide proper flow stream and specified GPM. Repair leaks at faucets and stops.

## 3.4 EXTRA STOCK

A. Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner.

## 3.5 FIELD QUALITY CONTROL

A. Upon completion of installation of plumbing fixtures, test fixtures to demonstrate capability and compliance with Specifications. Correct or replace malfunctioning units at site, then retest to demonstrate compliance.

## 3.6 PROTECTION

A. Protect fixtures and equipment from damage. Cover finished fixtures with cardboard. Fixtures are not to be used during construction by workers. Replace damaged items with new.

END OF SECTION

# SECTION 22 1329 - SANITARY SEWERAGE PUMPS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Submersible sewage pumps.

B. Related Sections include the following:

   1. Section 22 1343 - Facility Sewage Pumping Station

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

   1. Submersible sewage pumps.
   2. Guide rail system.

B. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

### 1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SEWAGE GRINDER PUMPS

A. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Liberty Pumps 2HP Duplex Grinder Pump Package (D3696LSGSG-Single Stage), or approved-equal, Owner's Representative-approved product.
2. Description: Factory-assembled and -tested sewage-pump units with guide-rail supports.
3. Pump type: Submersible, non-clog, explosion-proof, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage grinder pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: ASTM A-48 Class 25 cast iron, finned, with open inlet, and discharge fittings for connection to guide-rail support.
5. Impeller: Shall be an investment cast stainless steel impeller, with pump out vanes on the back shroud to keep debris away from the seal area. Shall be keyed and bolted to the motor shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, permanently grease-lubricated ball bearings designed to handle axial grinder pump thrust loads.
7. Seals: Mechanical. Protect motor from the pumping liquid.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump. All motors shall be oil filled and class B insulated NEMA B design, rated for continuous duty.

    a. Motor Housing Fluid: Oil.

    b. Motor Size: 2.0 Horsepower

10. Electrical Characteristics:
    a. Volts: 208/230
    b. Phases: Three
    c. Hertz: 60

11. Discharge Size: 2 inches NPS

12. Operating Characteristics: 30 U.S. GPM at 20 feet TDH

13. Power Cord: STW-A water resistant, 600V, 60° C, capable of continued exposure to the pumped liquid. Provide separate cord for seal fail probes and thermal detectors. The power cord shall be sized for the rated full load amps of the pump in accordance with the National Electric Code.

14. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.

e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

### 3.2 INSTALLATION

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.
2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

B. Wiring Method: Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

### 3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

### 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.5 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.

## 3.6 ADJUSTING

A. Adjust pumps to function smoothly. Lubricate as recommended by manufacturer.

B. Adjust control set points.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Government’s maintenance personnel to adjust, operate, and maintain the controls and pumps.

**END OF SECTION 22 1329**

# SECTION 22 1343 - FACILITY SEWAGE PUMPING STATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes:

1. Wet-well sewage pump basin and cover
2. Gate valves
3. Check valves
4. Plug valve
5. Pressure piping and fittings

B. Related Sections

1. Section 22 1329 - Sanitary Sewerage Pumps

### 1.3 PERFORMANCE REQUIREMENTS

A. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than 125 psig.

B. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

### 1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Include construction details, material descriptions, dimensions of individual components, rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Product Certificates: For each type of sewage pump, signed by product manufacturer.

D. Qualification Data: For Installer.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

I. Provide all drawings in AutoCAD format DWG and hard copy and in PDF format.

J. Provide Schematic ladder diagram with line numbers, wire numbers, pin numbers for all devices.

K. Provide Physical wiring diagram of back panel and back of door showing all pins on all devices and all wire numbers to all devices.

L. Provide Materials list of all components in XLS format with make model # source of supply

M. Provide Physical dimensional drawings to scale of outside of panel and inside of panel showing all components to scale.

N. Provide written (in MS Word DOC format) operations instructions, functional description of control logic line by line, troubleshooting guide, calibration instructions for entire system.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

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

D. Comply with UL 778, "Motor-Operated Water Pumps," for sewage pumps.

## 1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:

1. Notify Contracting Officer no fewer than two days in advance of proposed interruption of sanitary sewer service.
2. Do not proceed with interruption of sanitary sewer service without Contracting Officer’s written permission.

## 1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sewage pumping stations that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including wet well.
b. Faulty operation of sewage pumps, controls, or accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Wet Well: One year from date of Substantial Completion.
3. Warranty Period for Sewage Pumps and Controls: Five years from date of Substantial Completion.
4. Warranty Period for Accessories: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WET-WELL SEWAGE PUMP BASIN AND COVER

A. Basin: Watertight, cylindrical chamber with openings for pipe connections. Openings may be factory-cast or core drilled on site per manufacturer's specifications.

1. Material: Pre-manufactured Liberty duplex fiberglass wet well.

2. Dimensions: 36 inches, inside diameter

3. Wall Thickness: Per Manufacturer recommendations

4. Depth: 9.6' (underside of cover to floor of wet well)

5. Inlet Pipes: One 4" gravity sewer inlet

6. Outlet Pipes: One 2" pump discharge pipe

B. Basin Cover: Flat top manhole cover
1. Load Rating: H20 traffic loading
2. Access Hatch: Steel cover, and minimum 24 inch by 30 inch min. clear opening. Compatible with sewage pump guide rails.
3. Color and shape to be coordinated with Architect/Owner.

2.2 CONTROLS

A. Lift Stations (LS-1):

1. Each lift station contains two (2) pumps that shall run in a duplex alternating (one at a time) fashion, using an "on-demand" scheme controlled by float switch inputs.
2. The pumping mode of the submersible pumps shall depend on the input of four (4) float switches installed in the wet well:
3. High Level Alarm
4. Lag Pump On
5. Lead Pump On
6. Pumps Off
7. Normal system operation shall keep the wastewater liquid level between the Lead Pump On and Pumps Off floats.
8. The lead pump shall start when the Lead Pump On float is raised and shall remain on until the Pumps Off float drops.
9. During periods of high flow, the wastewater level in the wet well may rise to the point where the Lag Pump On float switch is raised. When this float is up, both pumps

shall run simultaneously and both pumps shall remain on until the pumps Off float drops or the minimum run timer is exhausted, whichever comes last.

10. If both pumps cannot keep up with the flow and the High Level Alarm float is raised, an alarm will be sent to notify the operator of the high level condition.

B. Lift Station Control Panel Features

1. In the event of an alarm, the control panel shall activate a local light and an audible alarm on the pump control shed, the remote annunciator at the building specified in the plumbing/electrical plans (scale house and/or transfer station). The control panel shall be capable of sending email alerts, provided the panel is connected via Ethernet to a network that has access to an email server.
2. Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.

C. Pump station control panel physical requirements and construction

1. Provide a complete UL 508A for class 1 Div 1 intrinsically safe controls for a duplex pump station ladder schematic diagram of the pump station logic and front panel layout showing all operators interface controls as follows:
2. Provide the following controls:
   a. Provide a main door interlocked circuit breaker to shut off entire panel when door is opened.
   b. 120/240VAC control transformer.
   c. Control logic is all 24VAC plug in relays all 3PDT octal base relays
   d. Provide 24VDC intrinsically safe relays or normal relay with intrinsically safe barriers.
   e. Provide A-O-C test switches on each of the five float switches to allow testing of control logic.
   f. Provide lightning protectors on each float switch circuit exiting panel.
   g. Provide GFCI for 240V/120VAC transformer secondary.
   h. Provide a 24VDC power supply for float switches and to provide power for alarm system and recharging 24VDC 7.5AH gell cell alarm battery.
   i. Provide HOA switches for each motor.
   j. Provide 24VAC Running time meter and operation counter and green run light for each motor operated by an aux contact on the motor starter.
   k. Provide a seal fail probe in each motor. Also provide a red seal fail light for indication only. Do not shut down pump on seal alarm.
   l. Provide internal thermal overload switch NC in each pump motor.
   m. Motor shall have two cords one for power and one common cord for seal fail / thermal detectors.
   n. Provide MCP with aux trip contact for each motor. Tie into overload alarm for a common alarm and also thermal detectors Provide a common red overload/breaker trip / thermal detector alarm light.
   o. Provide a common red overload / MCP breaker trip / thermal detector light indicator light for motor starter overload for each motor.
   p. Provide a general alarm light for any alarm condition and an external 24VDC strobe light external to building on a battery backup.
   q. Indicator lights 24VAC LED lamps, no incandescent lamps
   r. Provide a white power on light for 24VAC and 24VDC power supplies.
   s. Provide three phase voltage monitor to shut system down on phase fault. Provide a bypass test switch for voltage monitor.
   t. Provide an alternator with a manual switch to select either lead pump 1 or two or automatic alternation on each pump cycle.
   u. Provide 4 float switches thru intrinsically safe relays:

i. Provide AOC test switches for each float switch.
ii. High Level alarm light
iii. Lag Pump on
iv. Lead pump on
v. Both pumps off

v. Provide a common contact to energize a drain back external valve if both pumps are off, 10A @ 120VAC rated.
w. Provide one common time delayed general alarm light for all alarm functions as follows.
x. Provide a time delay in reset bus and alarm reset pushbutton to reset high and low level alarms. All other manually reset.
y. Provide a 24VDC battery backed up alarm external general alarm strobe light and alarm horn (with on/off silence switch) for any of the following conditions. Also provide a common NO dry contact for alarm external alarm for a dialer and a 24VDC external alarm voltage to main building for remote alarm for any of the following alarms.
i. Overload pump 1 or 2 or thermal detector
ii. MCP breaker trip pump 1 o 2
iii. Power loss AC or DC power loss
iv. High level alarm
z. Provide a 240v/24VAC single phase transformer for control power and to provide power for the following:
aa. Provide lightning arrestors for float switches and external remote alarm contacts
bb. Provide service entrance lightning arrestor on panel with circuit breaker
cc. On low or high voltage phase monitor relay shut control power off to panel, and energizes remote alarm contact, alarm 24VDC to main building and external alarm light and strobe on pump house.
dd. Duplex Pump Operation
i. Level rises to 1 pump on, pump runs till pump off float switch reached
ii. Level rises to 2 pump on lag float both pumps turn on till pump off float is reached
iii. High level alarm sounds general alarm and strobe.
iv. If one pump overloads / breaker trips, remaining pump is lead pump until reset, tie into alternator circuit.
v. If one pump is taken out of service with HOA switch in off, remaining pump becomes lead pump with each pump cycle.

D. Control Panel Mounting: Inside pump station control shed, on west wall. Install labels on panel face to identify switches and controls.
E. Wiring: Tin-copper wiring
F. Connection for Portable Generator: None required.

A.

2.3 ACCESSORIES

A. High-Water/Low-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm test switch and alarm silencer switch, and relay in control panel. Alarm horn to be mounted on exterior of pump station control shed.

B. High-Water/Low-Water Visual Alarm: UL1571, heavy-duty, cast-metal, wet-location-type fixture with 100-W bulb and red glass lens wired to turn on in conjunction with the high-water audio alarm. Alarm light to be mounted on exterior of pump control shed.

C. Provide a remote annunciator in office that will detect a contact closure over a #22AWG control cable at pump station and provide the following functions.

1. Provide a 24VDC power supply to drive 24VDC relay to monitor a contact closure in pump station control panel for any alarm, power loss, or any other alarm.
2. Provide on the annunciator face the following controls:
   24VDC power on light
3. General alarm red light for pump station Telephone dialer on / off switch
4. Energize a mini 1” diameter strobe light at reception desk and on annunciator and a sonalert for annunciation in addition to the general alarm light on annunciator. Provide a 4”x 6” panel at reception desk with a horn silence switch to silence sonalert and mini strobe light.
5. Provide a voice dialer in annunciator to dial up to 4 people with tone acknowledgement of alarm in remote annunciator panel.
6. Provide a dialer on/off switch. Dialer shall dial out on internal battery if annunciator panel loses power.
7. Provide a schematic diagram, physical wiring diagram, wire numbers on all wires.

## 2.4 VALVES

A. Valves and fittings, within pre-packaged Liberty Pump wet well system, shall be SCH-80 PVC or approved-equal.

## 2.5 SEWAGE PUMPING STATION FABRICATION

A. Air Vent: Duct fabricated from painted steel pipe, extended to above grade, outlet turned down, and with insect screen in outlet.

B. Field fabricate piping between unit components.

1. Use SCH-80 PVC pipe and fittings within wet well.
2. Use fittings for changes in direction and branch connections.
3. Flanged and union joints may be used instead of joints specified.
4. Use dielectric fittings for connections between ferrous- and copper-alloy piping.

C. Piping Connections: Unless otherwise indicated, make the following piping connections:
1. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

D. Valves: Ferrous alloy.

1. Sewage Pump Piping: Include gate valve and check valve on each discharge pipe.

## 2.6 SOURCE QUALITY CONTROL

A. Test and inspect sewage pumps according to HI 1.6, "Centrifugal Pump Tests." Include test recordings that substantiate correct performance of pumps at design head, capacity, suction lift, speed, and horsepower.

B. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of sewerage piping systems to verify actual locations of piping connections before sewage pumping station construction.

C. Proceed with construction only after unsatisfactory conditions have been corrected.

### 3.2 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Sections.

### 3.3 INSTALLATION

A. Install sewage pumping station components where indicated on the drawings, according to specific equipment and piping arrangement indicated.

B. Seal all wall penetrations with flanged gasket under and around shell per manufacturer’s specifications.

### 3.4 CONNECTIONS

A. Sanitary sewer piping installation requirements are specified in Division 33 Section "Sanitary Sewerage Piping." Drawings indicate general arrangement of piping.

B. Install piping adjacent to machine to allow service and maintenance.

C. Vent piping shall be provided from wet well to building plumbing. See plans for vent pipe routing.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.5 IDENTIFICATION

A. Install identifying labels permanently attached to equipment.

B. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.

C. Arrange for installing green detectable warning tape over all underground sewage piping. Tape materials and their installation are specified in section 33 3100 – Sanitary Sewerage Piping.

## 3.6 PAINTING

A. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with coal-tar epoxy-polyamide paint according to SSPC-Paint 16.

B. Paint field-welded areas to match factory coating.

## 3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform field tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. After constructing sewage pumping station and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
2. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace sewage pumping station components that do not pass tests and inspections and retest as specified above.

## 3.8 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.
2. Adjust pumps, accessories, control settings, and safety and alarm devices.

## 3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the sewage pumping station. Refer to Division 01 Section "Demonstration and Training."

**END OF SECTION 22 1343**

**SECTION 22 1353 – ON-SITE WASTEWATER TREATMENT SYSTEM**S

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

A. This section pertains to the complete construction of an on-site wastewater treatment and disposal system. The system consists of an alternate treatment technology (ATT), double compartment septic tank, effluent filter with demand dosed duplex pumping assembly, gravity distribution box, and capping fill trenches with perforated PVC pipes and rock drainage media. Final design of the ATT, septic tank, and effluent filter with pumps shall be coordinated between the Owner, Contractor and Orenco Systems, Inc. or approved equal.

B. The onsite wastewater treatment system shall be complete and operable. Work or materials that are not specifically mentioned or presented that are reasonably considered ancillary to a complete and functioning system shall be performed by the contractor the same as if described in these specifications and accompanying plans.

1.3 SUMMARY

A. Section Includes:

1. Septic tank.
2. Tank risers.
3. Septic tank effluent filter.
4. Dosing pumps.
5. Duplex submersible pumping system.
   a. Submersible effluent pumps.
   b. Control and alarm floats.
   e. Pump controller and panel.
6. Zone distribution box.
7. Perforated PVC pipe and inspection port.
8. Capping Fill Trenches

B. Related Requirements:

1. Section 31 0513 - Soils for Earthwork.
2. Section 31 0516 - Aggregates for Earthwork.
3. Section 31 2316 - Excavation.
4. Section 31 2317 - Trenching.
5. Section 31 2323 - Fill.
6. Section 33 3100 - Sanitary Sewerage Piping.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. As applicable to the product, include fabrication, assembly, and installation details; material descriptions, dimensions of individual components; rated capacities; operating characteristics; electrical characteristics; and, furnished specialties and accessories.

1. Septic tank.
2. Tank risers & lids.

3. Septic tank effluent filter and support system.
4. Dosing pump(s).
5. Floats.
6. Pump control and system alarm panel.
7. Zone distribution box.
8. Perforated PVC pipe.
9. Absorption Trench Sorted/Washed Rock.
10. Geotextile Fabric.
11. Capping Fill Material.
12. ATT pretreatment system.
13. Recirculating Splitter Valves.

B. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and Maintenance Data: For each type of product indicated. Include two (2) copies of manufacturer's operation and maintenance manuals.

1. Septic tank effluent filter.
2. Demand Dosing Pumps.
3. Pump control and system alarm panel.
4. ATT pretreatment system.
5. Recirculating Splitter Valve.

1.5 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 an application.

B. Pumps shall be CSA and UL listed as a submersible effluent pump.

C. Pump control and alarm panels shall be UL 508 or UL 698A for Class 1, Division 1 and NEMA4X for use in wet locations and the manufacturer/fabricator will have at least 5 years experience in the fabrication of wastewater system control panels.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Do not deliver products to the job site earlier than one week prior to scheduled commencing of installation.

B. Storage and handling of products at the job site shall in no way impair or damage the products.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions to the recommended equipment specified will be permitted with the express written approval of the OWNER'S REPRESENTATIVE. Substitutions will be approved only when the substituted item is equivalent or better in quality and performance than the item originally specified or as identified in these specifications. The final determination for "equivalents" rests with the OWNER'S REPRESENTATIVE.

2.2 GENERAL WASTEWATER TREATMENT SYSTEMS

A. Septic Tank and Effluent Filter

1. Tank shall be single-wall fiberglass underground storage tanks for water and sanitary wastewater storage as manufactured by Xerxes Corporation or Orenco.

2. Septic tank nominal capacity shall be minimum 1,500 gallons and the nominal diameter shall be 6’ with double compartment. Dimensions may vary by manufacturer.
3. Schedule 40 PVC pipe stubs and tees shall be factory installed.
4. Tank access openings shall be compatible with the specified PVC risers and shall be sized accordingly. Tank shall have one (1) 24-inch opening with risers and one (1) 30-inch opening with riser for the effluent filter.
5. The septic tank effluent filter shall be a commercial grade gravity flow septic tank effluent filter Model FT 1260-36AR by Orenco Systems, Inc. The filter shall be capable of filtering 1/8” or larger solids. The filter shall be rated for a mean cleaning time of greater than five (5) years at a design flow of 712 gpd. The filter shall be easily removable for servicing. The filter and filter housing will be completely removable from a slide rail for reuse in a secondary septic tank to be installed in a future phase of site development.
6. The filter unit will include an integral float tree with mercury type high-level alarm float.

B. Duplex Submersible Effluent Pumping System

1. Submersible Pumps
   a. Submersible pumps shall be effluent pumps PF-Series Submersible Effluent Pumps by Orenco. The pumps shall be capable of producing 10 gpm at a total dynamic head of 10 feet or as recommended by Orenco for pumping to the AX20 units adjacent to the septic tank.
   b. General Specifications:
      - 0.5 hp, 1-Phase, 240 Volt
      - 2” discharge
      - Minimum liquid level of 12”
      - 5-yr manufacturers warrantee on pump or retrofit liquid end from date of manufacture against defects in materials or workmanship

2. Pump Control and Alarm Floats
   a. The floats shall be mercury filled floats, signal rated an approved for use with intrinsically safe, Class 1, Division 1 applications. The float tree shall be removable without having to remove the pump vault or pumps. The float tree shall come with three (3) floats with the following configuration.

      Level 3 – High Level Alarm
      Level 2 – Override Timer
      Level 1 – Low Level Alarm

3. Splice Box
   a. A pump power cord and signal wiring splice box shall be provided inside the tank access riser. The splice box shall include watertight cord grips and shall be UL listed and NEMA4X rated for use in wet locations. The conduit to the splice box shall be sealed with a watertight and gas tight mechanical conduit seal outside the access riser.

4. Alarm and Duplex Pump Control Panel
   a. The alarm and control panel shall be for both the operation of the pumping systems and the three floats. The panel shall be UL 508 or UL 698A for Class 1, Division 1 and NEMA4X for use in wet locations. The panel shall include a visual light alarm and an audible alarm on the top of the panel. The panel shall include a dead-front to mount all operator devises and to protect devices and labels from the elements. Welded on mounting feet shall be provided; they shall be oversized to readily accommodate mounting the panel on 1 5/8-inch strut. All hardware shall be corrosion resistant. The operator devises shall be labeled to correctly indicate proper function.
   b. The controller shall be a PLC based controller for control and operation of a duplex pumping system with demand-based functionality. The three (3) pump control floats have the following configuration:

Level 3 – High Level Alarm
Level 2 – Override Timer
Level 1 – Low Level Alarm

c. Standard Components:

- Programmable Logic Unit: 120 VAC programmable logic unit with built-in LCD screen and programming keys. Provides control functions and timing for panel operation.
- Motor-Start Contactors: 120 VAC: 16 FLA, 1 hp, 60 Hz; 2.5 million cycles at FLA (10million at 50% of FLA). 240 VAC: 16 FLA, 3 hp, 60 Hz; 2.5 million cycles at FLA (10million at 50% FLA).
- Toggle Switches: Single-pole, double-throw HOA switch. 20 amps, 1 hp.
- Controls Circuit Breakers: 10 amps, OFF/ON switch. Single-pole 120 V. DIN rail mounting with thermal magnetic tripping characteristics.
- Pump Circuit Breakers: 20 amps, OFF/ON switch. Single-pole 120 V, double-pole 240 V. DIN rail mounting with thermal magnetic tripping characteristics.
- Audio Alarms: 95 dB at 24", warble-tone sound.
- Visual Alarms: 7/8" diameter red lens, "Push-to-silence." UL Type 4X rated, 1 W LED light, 120 VAC.
- Panel Enclosure: Dimensions as required to include applicable controls and wiring. Constructed of UV-resistant fiberglass; hinges and latch are stainless steel. To include dead-front. Conduit couplings provided.
- Intrinsically Safe Control Relays: 120 VAC. Listed per UL 698A, for Class 1 Div. 1, Groups A, B, C, D hazardous locations.
- Current Sensors: 120 VAC. Go/no-go operation. Pump fail indicator light on panel. Manual reset switch
- Heater: Anti-condensation heater. Self-adjusting; radiates additional wattage as temperature drops.
- Surge Arrestor: 120V. Status light on unit. Protects incoming power supply from electrical surges.
- Pump Run Lights: 7/8" diameter green lens. UL Type 4X rates, 1 W LED light, 120 VAC.
- Power Light: 7/8" diameter green lens. UL Type 4X rates, 1 W LED light, 120 VAC.

C. Septic Tank Risers & Lids

1. Risers shall be made of ribbed PVC pipe such as Perma-Loc brand as manufactured by Orenco Systems, Inc. Risers shall include female treaded adapters for anchoring compatible access lid.
2 Lids shall provide a secure covering for access risers and shall be capable of supporting a 2,500 lb wheel load. Lids will be provided with polyurethane, neoprene, or EPDM gaskets to ensure a watertight seal. Manufacturer shall supply with factory-installed insulation. Lids shall come with SS bolts for securing to risers.
3. Risers will be supplied with rubber grommets for creating watertight pipe penetrations. Grommets shall be secured to vaults with a single part adhesive such as ADH100 manufactured by Orenco Systems, Inc.
4. To ensure compatibility, one single manufacturer shall supply risers, lids, pipe and conduit seals, and anchoring mechanisms.

D. Capping Fill Trenches

1. Capping fill trenches shall be constructed using 4-inch perforated, solvent-weld ASTM D-3034 PVC pipe (SDR-35). End caps shall be of the same PVC and installed on the end of each seepage trench pipe. Drainage media shall consist of 3/4" to 2-1/2" river rock or crushed rock that has been sorted and washed (no minus).

E. Septage Measurement Tools

1. Contractor shall provide a minimum of one scum measuring utility gauge. The gauge shall consist of a minimum 3/8" diameter stainless steel rod with an incremental scale for measuring scum levels. The rod shall be bent at a 90-degree angle at the base to aid in identifying the scum "by feeling." The gauge shall be Model SMUG by Orenco Systems, Inc.
2. Contractor shall provide a minimum of one sludge measuring optical gauge. The body shall consist of 3/4" diameter Schedule 80 PVC with an incremental scale. The electronics shall consist of a 9-volt high intensity LED lamp encased in epoxy resin, a photosensor, and a 9-volt battery for power. The gauge shall be Model SMOG by Orenco Systems, Inc.

## PART 3 - EXECUTION

### 3.1 INSPECTION

A. Inspect prefabricated and delivered systems and components to ensure they conform to approved submittals and plans prior to installation.

### 3.2 INSTALLATION

A. Septic Tank and ATT Units

1. The tank installation is for non-traffic rating. The tanks shall be installed and tested in strict accordance with the manufacturers printed instructions for onsite wastewater applications in a non-traffic rated installation. The general layout and pipe locations are as indicated on the engineer's plans. If required by the tank manufacturer to retain warrantee, the tank installer shall be trained and or certified by the tank manufacturer in the installation of fiberglass underground storage tanks.

B. Tank Access Risers and Lids

1. Tank risers and appurtenances shall be installed per the riser manufacturer's printed instructions. Tank access risers are to be bonded to the tanks with approved adhesive. Pipe grommets will be secured to the risers to provide a watertight pipe seal using approved adhesive. Risers and lids shall extend approximately 3 inches above the natural ground surface and grading around the risers shall facilitate drainage away from the tank openings.

C. Duplex Submersible Pumping System

1. All pumping system components shall be installed per the manufacturer's printed instructions, the engineer's plans, and state and local regulations.
2. Bundle excess pump power cable and float control cable and secure with cable ties below the splice box.

D. Duplex Pump Control Panel and Septic Tank Alarm

1. Control panel shall be mounted on the exterior of the transfer station building in a location to be determined, Contractor shall coordinate with Owner's Representative. Panel shall be installed within sight of the pump motor or the panel shall be provided with a lockable disconnect switch. The center panel height shall be approximately 5 feet above the ground.

E. Zone Distribution Box

1. The zone distribution box shall be installed per the manufacturer's printed instructions and the engineer's plans.

F. Capping Trench Perforated Pipe

1. The perforated pipe shall be installed per the manufacturer's printed instructions and the engineer's plans. Perforations shall be directed downward as shown on the engineer's plans.
2. Trench bottoms shall be level to within ±0.1 feet.
3. Install an inspection port with threaded plug located in a plastic irrigation valve box at the end of each trench.
4. Include tracing wire and warning tape over the top of each trench.

G. Pipe Connections

1. Comply with requirements for piping in Section 33 3100 – Sanitary Sewerage Piping and the general layout and configuration of the engineer's plans.

3.3 FIELD QUALITY CONTROLS

A. Tanks shall be tested according to the manufacturer's printed instructions.

B. Duplex Pumping System

1. Manufacturer's Field Service: Engage a manufacturer approved service representative to inspect, test, and adjust components, assemblies, and equipment installations.
2. Perform visual inspection of systems.
3. Following installation fill the system with water.
4. After electricity has been energized, start pumps to confirm proper operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
6. Pump and controls will be considered defective if they do not pass tests and inspections.
7. Manufacturer's Startup and Demonstration Service: Engage a manufacturer approved service representative to start-up the pumping systems, adjust final control points and train the Government's maintenance personnel to adjust, operate and maintain the controls and pumps.

C. Zone Distribution Box

1. Cycle pump and visually inspect zone distribution boxes are properly flowing to each zone pipe system.
2. Zone distribution box will be considered defective if it does not pass tests and inspections.

**END OF SECTION 22 1353**

# SECTION 230100 - BASIC HVAC REQUIREMENTS

## PART 1 - PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 23.

### 1.2 SUMMARY

A. The Mechanical Contractor (M.C.) is defined as the HVAC contractor and his/her subcontractors and is responsible for all HVAC work as indicated on the plans. This Contractor shall also be responsible for Testing, Adjusting and Balancing and Building Automation/temperature controls.

B. Each contractor is responsible for reading and understanding this specification.

C. This Section includes general administrative and procedural requirements for HVAC installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:

1. Quality Assurance.
2. Submittals.
3. Drawings and Specifications.
4. Coordination Drawings.
5. Electronic Files.
6. Project Closeout.
7. Record Documents.
8. Maintenance Manuals.
9. Equipment and Systems Demonstration.
10. Delivery, Storage, and Handling.
11. Work Sequence.
12. Inspections, Permits, Fees and Regulations.
13. Workmanship.

D. Related Sections: The following sections contain requirements that relate to this section:

1. Division 23 Section "COMMON WORK RESULTS FOR HVAC," for materials and methods common to the remainder of Division 23, plus general related specifications:

### 1.3 QUALITY ASSURANCE

A. Equipment Selection: Equipment of greater or larger power, dimensions, weights, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting HVAC and electrical services, circuit breakers, conduit, motors, structural supports, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the

equipment are specified, the equipment must meet the design requirements and commissioning requirements.

B. Product Uniformity: In order to provide the owner with systems that are reasonably maintainable, the contractor shall make product selections to assure manufacturer uniformity in all cases possible. This includes, but is not limited to valves, dampers, etc.

## 1.4 SUBMITTALS

A. General: Follow the procedures specified in Division 01.

B. Submittals are generally categorized as follows:

1. Test reports, inspections, and compliance data
2. Product data
3. Shop drawings
4. Technical supporting data and calculations
5. Maintenance, installation and trouble-shooting data
6. Guarantees and Warranties

C. Refer to each individual section for specific submittal requirements. Incomplete submittals will not be accepted. Provide all submittals in PDF format.

D. The required Product Data submittals shall be forwarded as complete informational documents suitable to describe the performance characteristics of the product being submitted. In no case shall the content of these submittals be less informative than the products detailed/scheduled/specified within the contract documents. Incomplete product data submittals, as determined by the reviewing engineer, will be returned to the submitting contractor marked "incomplete", requiring the contractor/vendor to re-examine the specified requirements of the submittal.

## 1.5 DRAWINGS AND SPECIFICATIONS

A. Drawings indicate general arrangement of system and are to be followed insofar as possible. Deviations from drawings may be necessitated by field conditions. Detailed layouts of proposed departures to be submitted to Architect/Engineer for approval. Engineer written consent to change to be obtained before proceeding with work.

B. Drawings and Specifications to be considered cooperative and anything appearing in Specifications, but not on drawings, or vice versa, to be considered part of the Contract and to be executed.

C. Drawings indicate size and approximate location of various parts of work and are to be used as a general guide for installation. However, drawings are, to a considerable extent, diagrammatic and exact locations of piping, ductwork, etc., may appear on the drawings or must be worked out on job. However, no changes in sizes to be made without written approval of Engineer. Errors or omissions discovered by Bidding Contractors prior to bid openings, to be called to attention of Engineer without delay. Changes in plans or specifications resulting from such errors or omissions to be in effect only when corrected by Engineer by means of Addendum issued to all bidders prior to bid opening.

D. Comply with Architect’s instructions for minor modifications in location of piping, ductwork, etc., to achieve effects desired by Architect.

E. If a specific item is specified or on drawings for multiple trades, this contractor shall include all items in the bid regardless of other trades. Resolution will be by Addendum or Change Order.

## 1.6 PROJECT CLOSEOUT

A. In order to achieve a complete and commissioned project, each contractor is responsible for the following items:

1. Building Inspection Certificates.
2. As-Built Drawings.
3. Final Payment Request.
4. Waiver of Liens.
5. Demonstration Certificates signed by Owner.
6. Delivery of extra materials.
7. Return of Borrowed Keys and Working Permits.
8. Letter Declaring Punch List Items Completed.
9. Operation and Maintenance Manuals.
10. Final Guarantee and Execution of Warranties.
11. Other requirements specified in Division 1 Specifications.

## 1.7 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:
1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Common Work Results for HVAC". Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

B. Record drawings must be kept by each contractor as up-to-date as-built drawings during the course of the project. Failure to display up-to-date as-builts on a monthly basis may result in partial payment requests being delayed/denied by the reviewing parties.

## 1.8 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for equipment items:

1. Complete information on project equipment and services as was submitted during the course of the project including an approved copy of each Product Data Submittal. This information is solely intended to provide the owner with accurate, usable information on how to care for his facility.
2. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
3. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

4. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassemble; aligning and adjusting instructions.
5. Servicing instructions and lubrication charts and schedules.
6. MSDS for each chemical compound used in mechanical systems.
7. A list of all equipment used on the project including Contractor's purchase order numbers and suppliers name and address.

## 1.9 EQUIPMENT AND SYSTEMS DEMONSTRATION

A. Each contractor is responsible for verifying the complete operation of the equipment and systems installed as a part of the work. After the contractor is satisfied the work meets the specified intents and sequences of operation, the contractor shall schedule, through the Engineer, a session during which all aspects of the work are explained to the Owner's personnel and/or representatives.

B. This explanation session shall cover:

1. Items in the Maintenance Manuals.
2. Condition of the record drawings.
3. Location of equipment, both exposed and concealed.
4. Location of system control centers.
5. General overview of systems operation.
6. Items in need of specific attention.
7. Emergency shutdown procedures.

C. The general overview of systems operation shall include:

1. Mechanical Maintenance Procedures.
2. Comments on system accessibility.
3. System balancing procedures.
4. Special warrantees and procedures.

D. The intention of this specified item is for the Mechanical Contractor to help the Owner understand the mechanical systems in the facility.

## 1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Comply with the guidelines and restrictions set forth in the pre-construction meeting.

## 1.11 WORK SEQUENCE

A. The Work will be conducted with coordination of all Trades to provide the least possible interference to the activities of the Owner's personnel and to permit an orderly transfer of personnel and equipment to the new facilities.

B. The Work included in this project shall be terminated in a way which will allow future work to be continued in an advantageous manner. An advantageous manner shall be one which provides adequate access and the means by which existing work is easily extended.

1.12 INSPECTIONS, PERMITS, FEES AND REGULATIONS

A. Each contractor is responsible for submitting plans, paying fees, and organizing the required inspections to complete the Scope of Work. This includes, but is not limited to:

1. Building Department/Department of Commerce Inspections.
2. Pressure Piping Inspections.
3. Local Fire Department or Authority Inspection.
4. Owner's Risk/Loss Insurer Inspections.

B. All work and material to be accordance with all local, state and federal laws, ordinances, rules and regulations relating to work and latest edition of State and Local Mechanical Codes, including amendments. Where drawings or specifications exceed legal requirements, the design shall govern. However, no work to be installed contrary to or below minimum legal standards.

PART 2 - PRODUCTS

2.1 GENERAL

A. Not Applicable.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. All work shall be performed by workers skilled in the particular trade involved and shall be done in a neat, workmanlike manner, up to present standards and practices.

B. Unless specified otherwise, all materials shall be new and both workmanship and materials shall be of good quality.

C. The Contractor shall have in charge of the work at all times during construction a competent foreman or superintendent, experienced in the work to be installed under this division of the work and with previous experience as a foreman for the Contractor.

END OF SECTION 230100

# SECTION 230500 – COMMON WORK RESULTS FOR HVAC

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Refer to any special instructions provided by the Construction Manager.

### 1.2 SUMMARY

A. This Section includes the following:
   1. Equipment installation requirements common to equipment sections.
   2. Painting and finishing.
   3. Supports and anchorages.

### 1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:

   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

### 1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

1.5 WARRANTY

A. Warranty: This section applies to all sections for Division 23. Manufacturer's standard form in which manufacturer agrees to replace components of all equipment that fail in materials or workmanship within specified one year warranty period. The warranty period does not begin until Certificate of Occupancy has been obtained from the Authority having Jurisdiction. Contractor will provide extended warranty at their cost to ensure a full one year warranty for date of Certificate of Occupancy. In addition to the standard one year warranty of all equipment and components, extended warranties are required for the following:
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
   2. Warranty Period for Solid-State Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
   3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.6 COORDINATION

A. Arrange for chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - EXECUTION

2.1 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

2.2 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

2.3 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

2.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

END OF SECTION 230500

# SECTION 230548 - VIBRATION AND SEISMIC CONTROLS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Open-spring isolators.
4. Resilient pipe guides.
5. Elastomeric hangers.
6. Spring hangers.
7. Mechanical anchor bolts.
8. Seismic Restraint

### 1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.

    a. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Seismic Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, forces required to select vibration isolators and for designing vibration isolation bases.

    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
3. 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 the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
    d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction showing maximum ratings of restraint items and the basis for approval (tests or calculations).

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Welding certificates.

C. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For spring mounts to include in operation and maintenance manuals.

## 1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Design to be based on 110 MPH Ult. Design wind speed..

B. Seismic-Restraint Loading:

1. Site Class: B. Design Category: B.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: II.

    a. Component Importance Factor: 1.0

3. Seismic response coefficient: Cs = 0.037.
4. Refer to structural drawings for more seismic information.

### 2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.

5. Surface Pattern: Smooth pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.

    a. Surface Pattern: Smooth pattern.
    b. Infused nonwoven cotton or synthetic fibers.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.

2. Mounting Plates:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the 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.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## 2.5 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.6 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.7 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Kinetics Noise Control, Inc.
    d. Mason Industries, Inc.
    e. Vibration Eliminator Co., Inc.

f. Vibration Isolation.
g. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the 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.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.8 MECHANICAL ANCHOR BOLTS

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

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in 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.

## 2.9 SNUBBERS

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

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Mountings & Controls, Inc.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

## 2.10 RESTRAINT CHANNEL BRACINGS

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

1. Cooper B-Line, Inc.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.11 RESTRAINT CABLES

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

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

## 2.12 SEISMIC-RESTRAINT ACCESSORIES

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

1. Cooper B-Line, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO.

B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. 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 used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

### 3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

D. Equipment Restraints:

1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
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 an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

I. 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.

J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

K. 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 structural engineer 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, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the 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 the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

## 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 221116 "Domestic Water Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least two of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system 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.

3.7 GENERAL INSTALLATION REQUIREMENTS

A. The following general requirements include but are not limited to the following:

1. Material used for seismic sway bracing such as cables, rods, frames, angles, hangers or anchors shall be in conformance with a nationally recognized standard.

2. Seismic sway bracing shall not be installed with bracing angles greater than 60 degrees or less than 45 degrees from horizontal, with a maximum of 2.5 degrees of variation from parallel or perpendicular to the run.

3. Equipment with an operating weight over 75 pounds, such as fans, heat exchangers and humidifiers, installed rigidly in-line with the duct system, shall be restrained independently of the duct system.

4. Use either cable or solid bracing for all situations. Do not mix bracing types.

5. All runs have a minimum of two transverse braces and one longitudinal brace (a run is defined as a length of duct or pipe without any change in direction).

B. Location and Spacing of Required Sway Bracing

1. The location and maximum distance between sway braces shall be determined by the responsible design professional.

2. Sway bracing shall be installed at an angle of no less than 30 degrees from vertical and in the bracing location identified below under the heading 1) Basic Sway Bracing Locations as well as at the maximum intervals between bracing listed below under the heading 2) Maximum Spacing of Transverse and Longitudinal Sway Bracing.

a. Basic Sway Bracing:

1) Suspended rectangular units of equipment shall be provided with a minimum of one sway brace at each corner.

2) Suspended runs of pipe, conduit, ducts, bus, etc. shall be provided with transverse and longitudinal sway bracing meeting the spacing limitations. Provide a transverse and longitudinal sway brace at the beginning and end of each continuous run greater than 12 feet; and within 24 inches of one end of each horizontal off-set (horizontal change in direction) of 45 degrees or more; and within 24 inches of the top and bottom of each vertical offset (vertical change in direction).

3) A four way sway brace shall be provided at the top of all pipe risers exceeding 3 feet in length and at intervals not exceeding 25 feet.

4) Lateral/transverse sway braces shall be installed within 24 inches of every other flexible coupling not required for flexibility due to differential movement of pipe or conduit.

5) Lateral/transverse sway braces shall be installed at each end of each run (runout/arm over) of pipe, conduit, duct, etc. 6 feet or longer in length.

6) When rod stiffeners are required, sway bracing shall be located within 6 inches of hangers with rod stiffeners.

7) Hangers for platforms, trapezes and similar multiple hanger supported equipment or systems components shall be provided with rod stiffeners or by structural analysis performed verifying that rod stiffeners are not required.

b. Maximum Spacing of Transverse and Longitudinal Sway Bracing:

Additional transverse and longitudinal bracing shall be installed at the maximum intervals along the length of a suspended run of pipe, conduit or duct as follows:

Note: The maximum spacing of sway braces for materials which are not listed below shall be calculated by the responsible licensed design professional.

1) Schedule 10 and stronger steel pipe (including galvanized pipe).

Single hanger supported runs of pipe less than 2 ½ inches in diameter:
Transverse sway bracing: Maximum spacing 30 feet
Longitudinal sway bracing: Maximum spacing 60 feet

Single hanger supported runs of pipe 2 ½ inches and larger in diameter:
Transverse sway bracing: Maximum spacing 40 feet
Longitudinal sway bracing: Maximum spacing 80 feet

2) Copper Pipe

Single hanger supported runs less than 2 ½ inches in diameter:
Transverse sway bracing: Maximum spacing 30 feet
Longitudinal sway bracing: Maximum spacing 60 feet

Single hanger supported runs of pipe 2 ½ inches and larger in diameter:
Transverse sway bracing: Maximum spacing 40 feet
Longitudinal sway bracing: Maximum spacing 80 feet

3) Code Complying Sheet Metal Ducts
With a cross sectional area > 6 square feet
Transverse sway bracing: Maximum spacing 40 feet
Longitudinal sway bracing: Maximum spacing 80 feet

4) Steel Conduit

Single hanger supported runs of steel conduit less than 2 ½ inches in diameter:

Transverse sway bracing: Maximum spacing 30 feet
Longitudinal sway bracing: Maximum spacing 60 feet

Single hanger supported runs of steel conduit 2 ½ inches and larger in diameter:

Transverse sway bracing: Maximum spacing 40 feet
Longitudinal sway bracing: Maximum spacing 80 feet

Note: For EMT use one half of the above maximum spacing

5) Trapeze Supports: Trapeze Supported Pipe, Sheet Metal Ducts, Conduit, Bus-Duct, Cable Tray, etc.

Transverse sway bracing: Maximum spacing 40 feet
Longitudinal sway bracing: Maximum spacing 40 feet

Note: All pipe(s), sheet metal ducts, conduit, bus-duct, cable tray, etc., not individually sway braced, shall be securely anchored to the trapeze type supports being sway braced

END OF SECTION 230548

# SECTION 230553 - IDENTIFICATION SYSTEMS FOR HVAC

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

a. Brady Corporation.
b. Brimar Industries, Inc.
c. Carlton Industries, LP.
d. Champion America.
e. Craftmark Pipe Markers.
f. emedco.
g. Kolbi Pipe Marker Co.
h. LEM Products Inc.
i. Marking Services, Inc.
j. Seton Identification Products.

2. Material and Thickness: aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. LEM Products Inc.
8. Marking Sevices Inc.
9. National Marker Company.
10. Seton Identification Products.
11. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.3 PIPE LABELS

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

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Sevices Inc.
11. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

# PART 3 - EXECUTION

## 3.1 PREPARATION

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

## 3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

## 3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

END OF SECTION 230553

# SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

2. Control system verification.

3. Testing, Adjusting, and Balancing of the following Equipment:
   a. Heat Pump units.
   b. Fan Coils
   c. Exhaust fans

### 1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

### 1.4 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 60 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. System Readiness Checklists: Submit system readiness checklists as specified in "Preparation" Article.

C. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

## 1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC, NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

J. Examine operating safety interlocks and controls on HVAC equipment.

K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Instrumentation to be used.

3. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Duct systems are complete with terminals installed.
b. Volume, smoke, and fire dampers are open and functional.
c. Clean filters are installed.
d. Fans are operating, free of vibration, and rotating in correct direction.
e. Variable-frequency controllers' startup is complete and safeties are verified.
f. Automatic temperature-control systems are operational.
g. Suitable access to balancing devices and equipment is provided.

## 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

## 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

E. Verify that motor starters are equipped with properly sized thermal protection.

F. Check dampers for proper position to achieve desired airflow path.

G. Check for airflow blockages.

H. Check condensate drains for proper connections and functioning.

I. Check for proper sealing of air-handling-unit components.

J. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

## 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet.
    b. Measure static pressure directly at the fan inlet.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

C. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

## 3.6 PROCEDURES FOR HEAT PUMPS UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

## 3.7 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Refrigerant pressures and temperatures.
2. Dry-bulb temperature of entering and leaving air.
3. Wet-bulb temperature of entering and leaving air for cooling coils.
4. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

## 3.8 VIBRATION TESTS

A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on Transfer Building dust removal exhaust fans.

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.

2. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
3. Verify calibration date is current for vibration meter before taking readings.

C. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.

## 3.9 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

## 3.10 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

## 3.11 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Notes to explain why certain final data in the body of reports vary from indicated values.
13. Test conditions for fans performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Fan drive settings including settings and percentage of maximum pitch diameter.
    e. Settings for supply-air, static-pressure controller.
    f. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.

2. Motor Data:
    a. Horsepower and rpm.
    b. Volts, phase, and hertz.
    c. Full-load amperage and service factor.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Coil static-pressure differential in inches wg.
    g. Outdoor airflow in cfm.
    h. Return airflow in cfm.
    i. Outdoor-air damper position.
    j. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

    a. System identification.
    b. Location.
    c. Coil type.
    d. Make and model number.
    e. Face area in sq. ft..
    f. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.
    b. Average face velocity in fpm.
    c. Air pressure drop in inches wg.
    d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
    e. Entering-air, wet- and dry-bulb temperatures in deg F.
    f. Leaving-air, wet- and dry-bulb temperatures in deg F.
    g. Refrigerant suction pressure in psig.
    h. Refrigerant suction temperature in deg F.

G. Electric Heater Test Reports: For electric heaters installed include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Capacity in Btu/h and KW
    d. Number of stages.
    e. Connected volts, phase, and hertz.
    f. Rated amperage.

2. Test Data (Indicated and Actual Values):
    a. Entering-air temperature in deg F.
    b. Leaving-air temperature in deg F.
    c. Voltage at each connection.
    d. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Sheave make, size in inches, and bore.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

I. Additional Testing
1. Space Static Pressure: Adjust sensors, fan operation, damper settings and sensor setpoint to achieve a positive space static pressure of 0.05” adjustable.
2. For main Transfer Station building, test for interior negative static pressure established with all exhaust fans running at 100% capacity. In addition, perform a smoke bomb test in the presence of the engineer for the main transfer floor area and for the load out area to ascertain exhaust system effectiveness.

J. Instrument Calibration Reports:

1. Report Data:

    a. Instrument type and make.
    b. Serial number.
    c. Application.
    d. Dates of use.
    e. Dates of calibration.

## 3.12 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.

B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

F. Prepare test and inspection reports.

## 3.13 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

# SECTION 230713 - DUCT INSULATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes insulating the following duct services. Note that all exposed insulation shall have a white or light colored jacket finish.

1. Indoor, concealed outdoor air.
2. Indoor, exhaust between isolation damper and penetration of building exterior.
3. Indoor round supply and return.

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail application of field-applied jackets.

### 1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

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

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied PSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

a. CertainTeed Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

a. CertainTeed Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

## 2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. Foster Brand; H. B. Fuller Construction Products.
d. K-Flex USA.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Mon-Eco Industries, Inc.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Vapor-Barrier Mastic:

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

   a. Foster Brand; H. B. Fuller Construction Products.
   b. Knauf Insulation.
   c. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

## 2.3 SEALANTS

A. PSK and Metal Jacket Flashing Sealants:

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

5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. PSK Jacket: Metalized polypropylene-scrim-kraft; complying with ASTM C 1136.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.5 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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

    a. Avery Dennison Corporation, Specialty Tapes Division.
    b. Compac Corporation.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insulation.
    e. Venture Tape.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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

    a. Avery Dennison Corporation, Specialty Tapes Division.
    b. Compac Corporation.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insulation.

e. Venture Tape.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

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

a. Compac Corporation.
b. Ideal Tape Co., Inc., an American Biltrite Company.
c. Venture Tape.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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

a. Avery Dennison Corporation, Specialty Tapes Division.
b. Compac Corporation.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.
e. Venture Tape.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

## 2.6 SECUREMENTS

A. Bands:

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

a. ITW Insulation Systems; Illinois Tool Works, Inc.
b. RPR Products, Inc.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

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

      1) AGM Industries, Inc.
      2) Gemco.
      3) Hardcast, Inc.
      4) Midwest Fasteners, Inc.
      5) Nelson Stud Welding.

2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

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

      1) AGM Industries, Inc.
      2) Gemco.
      3) Midwest Fasteners, Inc.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

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

      1) Gemco.
      2) Midwest Fasteners, Inc.

   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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

1) AGM Industries, Inc.
2) Gemco.
3) Hardcast, Inc.
4) Midwest Fasteners, Inc.
5) Nelson Stud Welding.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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

1) Gemco.
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" firestopping and fire-resistive joint sealers.

## 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

4. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Architect requires that all visible interior insulation jacket be light/white colored.

C. Do not field paint aluminum or stainless-steel jackets.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed round supply and return air.
2. Indoor outside air.
3. Indoor exhaust between HRV and penetration of building exterior.

B. Items Not Insulated:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1 unless insulation is also indicated, such as exterior ductwork.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Round concealed supply and return air, insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Exhaust-air duct insulation between HRV and penetration of building exterior shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

END OF SECTION 230713

# SECTION 230900 - INSTRUMENTATION AND CONTROL

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

### 1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. MS/TP: Master slave/token passing.

D. PID: Proportional plus integral plus derivative.

E. RTD: Resistance temperature detector.

### 1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. 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.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Written description of sequence of operation.

4. Schedule of dampers including size, leakage, and flow characteristics.
5. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

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

C. Comply with ASHRAE 135 for DDC system components.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

## 1.7 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 CONTROL SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

B. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type.

2.3 TIME CLOCKS

A. Available Manufacturers:

1. ATC-Diversified Electronics.
2. Grasslin Controls Corporation.
3. Paragon Electric Co., Inc.
4. Precision Multiple Controls, Inc.
5. SSAC Inc.; ABB USA.
6. TCS/Basys Controls.
7. Theben AG - Lumilite Control Technology, Inc.
8. Time Mark Corporation.

B. Solid-state, programmable time control with separate programs; battery backup; keyboard interface and manual override; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm.

2.4 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:

a. BEC Controls Corporation.
b. Ebtron, Inc.
c. Heat-Timer Corporation.
d. I.T.M. Instruments Inc.

e. MAMAC Systems, Inc.
f. RDF Corporation.

2. Accuracy: Plus or minus 0.5 deg F at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
5. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.

6. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. Pressure Transmitters/Transducers:

1. Manufacturers:

a. BEC Controls Corporation.
b. General Eastern Instruments.
c. MAMAC Systems, Inc.
d. ROTRONIC Instrument Corp.
e. TCS/Basys Controls.
f. Vaisala.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
b. Output: 4 to 20 mA.
c. Building Static-Pressure Range: 0- to 0.25-inch wg.
d. Duct Static-Pressure Range: 0- to 5-inch wg.

D. Thermostat:.

1. 5 day/2 day programmable with 4 periods per day and occupancy override.
2. System powered with battery backup
3. Auto Changeover
4. Touch and Go programming
5. On screen heat and cool indicators
6. Large backlit LCD screen.
7. Keypad lockout security with passcode protection.
8. Proportional integral control of heating and cooling stages.

E. Room thermostat accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

## 2.5 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Spring-Return Motors for Dampers larger than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

## 2.6 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Low-Leakage Type: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.
4. For fire pump building outside air, provide insulated damper similar to Greenheck ICD-45.

## 2.7 CONTROL CABLE

A. Electronic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

B. Install control equipment and systems as required, in accordance with system manufacturer’s written instructions, and with recognized industry practices, and ensure that equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA’s “Standard of Installation” pertaining to general electrical installation practices.

C. Install all raceway and wiring in accordance with all requirements of electrical specifications

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units.

3.2 INSTALLATION

A. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

B. Install guards on thermostats in the following locations:

1. All areas except the transfer station office space and the scale house.

C. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

E. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

F. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

G. Install electronic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

## 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

## 3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

3. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

4. Temperature:

    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

5. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
6. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
7. Provide diagnostic and test instruments for calibration and adjustment of system.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

## 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230900

# SECTION 230993 - SEQUENCE OF OPERATIONS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes control sequences for HVAC systems, subsystems, and equipment.

### 1.3 ACTION SUBMITTALS

A. Product Data:

1. An instrumentation list for each controlled system.
2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:

1. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
2. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

### 1.4 Codes and Standards

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:

1. National Electric Code(NEC)

### 1.5 SEQUENCES OF OPERATION

A. Fan Coils/Heat Pumps/EDC-1

1. Provide programmable thermostat with digital display and battery backup as located on the drawings. Refer to energy code notes for additional details.

2. Interlock fan coil with heat pump operation. System to operate from packaged controls by unit manufacturer.

3. Provide defrost cycle for heat pumps.

4. Where outside air intake is shown, interlock fan coil with outside air motorized damper to open damper when fan is energized.

5. For FC-3, interlock operation with EDC-1. First stage of heating is via heat pump. Upon drop in temperate of 3 degrees below set point, lock out heat pump operation and energize electric duct coil SCR control to maintain setpoint. EDC-1 operation to be locked out whenever outdoor temperature is above 25 deg adjustable.

Exhaust and fans

6. Transfer Station EF-1 thru 16 shall each have a wall mounted controller with wire guard. Controller shall programmable to provide on-off operation and shall allow each fan's VFD to be manually and remotely adjusted for desired fan speed. Interlock motorized dampers with respective fan.

7. Scale House EF-1: Interlock with light switch.

8. Fire Pump Building EF: Fan to operate from a wall mounted thermostat for ventilation of the space – Set point = 80 deg adjustable. Interlock fan with associated motorized damper and with outside air intake motorized damper.

Electric Heat

9. Provide wall thermostat with locking cover for electric wall and unit heaters UNO.

10. Transfer Station Office Vestibule: Electric wall heater to have automatic controls to shut off heat when outdoor air temperature is greater than 45 deg F. Heating shall be controlled by thermostat with a setpoint of 60 deg F or less.

Heat Recovery Ventilator

11. HRV to operate from a programmable time clock. Interlock unit with outside air and exhaust air motorized dampers. Provide frost control cycle.

END OF SECTION 230923

# SECTION 233113 - METAL DUCTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:
   1. Fittings.
   2. Seam and joint construction.
   3. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:

   1. Sheet metal thicknesses.
   2. Joint and seam construction and sealing.
   3. Reinforcement details and spacing.
   4. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Welding certificates.

E. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

# PART 2 - PRODUCTS

## 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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

a. Ductmate Industries, Inc.
b. Lindab Inc.
c. McGill AirFlow LLC.
d. MKT Metal Manufacturing.
e. SEMCO LLC.
f. Sheet Metal Connectors, Inc.
g. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

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

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. (Deleted)

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

a. CertainTeed Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Owens Corning.

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.6 HANGERS AND SUPPORTS

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

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

# PART 3 - EXECUTION

## 3.1 DUCT INSTALLATION

A. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

B. Install round and flat-oval ducts in maximum practical lengths.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

## 3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

D. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.

3. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
4. Conditioned Space, Exhaust Ducts: Seal Class B.
5. Conditioned Space, Return-Air Ducts: Seal Class C.

## 3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached. Powder actuated fasteners are not allowed.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

## 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

3.8 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to fan coil units:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 24.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

C. Exhaust and Return Air Ducts:

1. Ducts Connected for exhaust or return (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 24.
d. SMACNA Leakage Class for Round and Flat Oval: 24.

D. Liner (apply to both single and double wall ducts):

1. Supply and Return Air rectangular Ducts: Fibrous glass, Type I, 2 inches thick.

E. Elbow Configuration:

1. Provide turning vanes for all rectangular 90 degree elbows.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

END OF SECTION 233113

# SECTION 233300 - AIR DUCT ACCESSORIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Backdraft dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Detail duct accessories fabrication and installation in ducts and other construction:

a. Control-damper installations.
b. Fire-damper, including sleeves; and duct-mounted access doors and remote damper operators.
c. Wiring Diagrams: For power, signal, and control wiring.

### 1.4 CLOSEOUT SUBMITTALS

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

### 1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 20 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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

2.2 MATERIALS

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

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

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

1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Cesco Products; a division of MESTEK, Inc.
3. Flex-Tek Group.
4. Greenheck Fan Corporation.
5. Lloyd Industries, Inc.
6. Nailor Industries Inc.
7. NCA Manufacturing, Inc.
8. Pottorff.
9. Ruskin Company.
10. Vent Products Co., Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 3-inch wg.

E. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.

F. Blade Action: Parallel.

G. Blade Seals: Neoprene, mechanically locked.

H. Tie Bars and Brackets: Galvanized steel.

I. Return Spring: Adjustable tension.

J. Bearings: synthetic pivot bushings.

K. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.

## 2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

a. Aire Technologies.
b. American Warming and Ventilating; a Mestek Architectural Group company.
c. Flexmaster U.S.A., Inc.
d. Flex-Tek Group.
e. McGill AirFlow LLC.
f. Nailor Industries Inc.
g. Pottorff.
h. Ruskin Company.
i. Trox USA Inc.
j. Vent Products Co., Inc.

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Galvanized-steel, 0.064 inch thick.

B. Low-Leakage, Steel, Manual Volume Dampers:

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

a. American Warming and Ventilating; a Mestek Architectural Group company.
b. Flex-Tek Group.
c. McGill AirFlow LLC.
d. Nailor Industries Inc.
e. Pottorff.
f. Ruskin Company.
g. Trox USA Inc.
h. Vent Products Co., Inc.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.

5. Blades:

    a. Multiple or single blade.
    b. Opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized, roll-formed steel, 0.064 inch thick.

6. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Blade Seals: Neoprene.
8. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

## 2.5 CONTROL DAMPERS

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

1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Arrow United Industries.
3. Cesco Products; a division of MESTEK, Inc.
4. Flex-Tek Group.
5. Greenheck Fan Corporation.
6. Lloyd Industries, Inc.
7. McGill AirFlow LLC.
8. Metal Form Manufacturing, Inc.
9. Nailor Industries Inc.
10. NCA Manufacturing, Inc.
11. Pottorff.
12. Ruskin Company.
13. Vent Products Co., Inc.
14. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Blades:

1. Multiple blade with maximum blade width of 6 inches.
2. Opposed-blade design.
3. Galvanized-steel.
4. 0.064 inch thick single skin.

5. Blade Edging: Closed-cell neoprene.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

D. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:

1. Oil-impregnated bronze or molded synthetic.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

## 2.6 FIRE DAMPERS

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

1. Aire Technologies.
2. American Warming and Ventilating; a Mestek Architectural Group company.
3. Arrow United Industries.
4. Cesco Products; a division of MESTEK, Inc.
5. Greenheck Fan Corporation.
6. Nailor Industries Inc.
7. NCA Manufacturing, Inc.
8. Pottorff.
9. Prefco.
10. Ruskin Company.
11. Vent Products Co., Inc.
12. Ward Industries; a brand of Hart & Cooley, Inc.

B. Rated and labeled according to UL 555 by an NRTL.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking,galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.7 TURNING VANES

A. Manufacturers: Subject to compliance with requirements

1. Aero-Dyne Sound Control Co.
2. CL WARD & Family Inc.
3. Ductmate Industries, Inc.
4. Duro Dyne Inc.
5. Elgen Manufacturing.
6. Hardcast, Inc.
7. METALAIRE, Inc.
8. SEMCO LLC.
9. Ward Industries; a brand of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

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

1. Aire Technologies.
2. American Warming and Ventilating; a Mestek Architectural Group company.
3. Cesco Products; a division of MESTEK, Inc.
4. CL WARD & Family Inc.
5. Ductmate Industries, Inc.
6. Elgen Manufacturing.
7. Flexmaster U.S.A., Inc.
8. Greenheck Fan Corporation.
9. McGill AirFlow LLC.
10. Nailor Industries Inc.
11. Pottorff.
12. Ventfabrics, Inc.
13. Ward Industries; a brand of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

## 2.9 FLEXIBLE CONNECTORS

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. Elgen Manufacturing.
5. Hardcast, Inc.
6. JP Lamborn Co.
7. Ventfabrics, Inc.
8. Ward Industries; a brand of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz. /sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz. /sq. yd.

2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

## 2.10 FLEXIBLE DUCTS

A. Thermaflex Type M-KE or equal.

B. Insulated, Acoustic Flexible Duct: UL 181, CPE duct liner bonded and supported by helically wound, spring-steel wire; fibrous-glass insulation; fiberglass reinforced metallized film laminate vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: 4.2.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers according to UL listing.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
2. Control devices requiring inspection.
3. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.

J. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect terminal units to supply ducts directly.

N. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with draw bands.

P. Install duct test holes where required for testing and balancing purposes.

## 3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

# SECTION 233423 - HVAC EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Centrifugal fans.
2. Ceiling exhaust fans.
3. Fan coils and heat pumps
4. Heat recovery ventilator
5. Electric heaters

### 1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations and sea level.

B. Operating Limits: Classify according to AMCA 99.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, seismic restrain and mountings, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

B. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria.

1. Seismic and Vibration Isolation Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

2. Filters: one set for construction, one set installed at turnover and one set attic stock.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members and seismic restraint requirements.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Breidert Air Products.
2. Carnes Company.
3. FloAire.
4. Greenheck Fan Corporation.
5. JencoFan.
6. Loren Cook Company.
7. PennBarry.

B. Housing: Steel

C. Fan Wheel: Aluminum non overloading centrifugal wheels.

D. Transfer Station EF-1 thru 8 requirements: Belt driven with explosion proof motor. Provide with VFD and internal thermal overload protection. Configure for wall mounted configuration. Provide with solid steel shafts and self-aligning bearings. Provide with disconnect, spark resistant construction and inlet fan guard.

E. Transfer Station EF-9 thru 16 requirements: Belt driven with explosion proof motor. Provide with VFD and internal thermal overload protection. Provide with disconnect, spark resistant construction, inlet fan guard and inlet/outlet flange kits.

F. Fire Pump Building Exhaust fan: Provide with disconnect and roof curb.

## 2.2 CEILING EXHAUST FANS

A. Housing: Galvanized-steel sheet with liner.

B. Steel Fan Wheel

C. Accessories:

1. Disconnect, backdraft damper and metal ceiling grille.

## 2.3 SPLIT SYSTEM HEAT PUMPS

A. Codes and Standards: ARI Standard 360, ASHRAE Standard 15, ASHRAE 90A, U.L.

B. Manufacturers: Subject to compliance with requirements, provide heat pumps manufactured by one of the following: Daikin, Carrier, Lennox, Trane, York, Mitsubishi or approved equal.

C. General: Factory-assembled and tested heat pumps, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. See schedule for capacity and electrical characteristics..

D. Accessories:

Unit mounting assembly. Mounting to be on vibration isolators w/ snow legs for snow protection.

Drain pan heater and disconnect.

Air adjustment grille.

Back and side protection wire net.

Transfer Station heat pump HP-1 to be configured for low temperature operation capable of 80% heating capacity at -13 deg F.

E. Install heat pumps in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer’s recommended clearances.

## 2.4. CONDENSING UNITS

A. Codes and Standards: ARI Standard 360, ASHRAE Standard 15, ASHRAE 90A, U.L.

B. Manufacturers: Subject to compliance with requirements, provide condensing units manufactured by one of the following: Daikin, Carrier, Lennox, Trane, York, Mitsubishi or approved equal.

C. General: Factory-assembled and tested condensing units, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. See schedule for capacity and electrical characteristics. Units shall be capable of operating down to -4 deg F.

D. Accessories:

Unit mounting assembly. Mounting to be on vibration isolators w/ snow legs for snow protection.

Drain pan heater and disconnect.

Wind baffle and field switch for low ambient operation.

E. Install Condensing units in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

2.5 ELECTRIC HEATERS

A. Electric Unit Heaters

20 gauge casing with removable access panels to for service, outlet diffuser with individually adjustable louvers, hi temp limit, electric heating element, disconnect and thermostatic control

B. Electric Wall and Cabinet Heaters

Surface and concealed mounted cabinet. Provide with hi temp limit, electric heating element, fan and disconnect. Refer to drawings for thermostat location.

Install unit heaters according to manufacturer's written instructions.

For wall heaters, provide anodized aluminum finish, color as selected by Architect.

C. Electric Duct heater: zero clearance duct heater with fan interlock, power and control terminal boards, auto reset for primary temperature protection, manual reset for secondary protection, air flow switch, SCR control, disconnect and pilot light.

2.6 SPLIT SYSTEM FAN COILS

A. Wall or ceiling mounted Indoor fan coil, operable with R-410A. Provide electronic expansion valve, direct drive ECM motor with auto cfm adjustment. Provide with cabinet having sound absorbing insulation, condensate pan and condensate pump, DX coil and filters. Provide wall mounted thermostat.

2.7 HEAT RECOVERY VENTILATOR

A. Provide heat recovery ventilator complete with cross flow, minimum 80% efficient cores, 5 speed/4 mode controller, microprocessor circuit board with built in interlock contacts, defrost control, cabinet insulation, forward curved blowers, filters and digital wall controller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide vibration isolation: As scheduled.

B. Provide Seismic restraint.

C. Install with required clearances and access for maintenance.

E. Condensate piped to indirect waste connection.

G. Install factory furnished devices for field installation.

3.2 FIELD QUALITY CONTROL

A. Inspect for and remove shipping bolts, blocks and tie-down straps.

B. After energizing units: Test units for proper fan rotation. Test and adjust controls and internal safeties. Replace malfunctioning units and retest.

C. Thoroughly clean exposed portions of equipment. Install new filters prior to final test and balance and again prior to final acceptance.

END OF SECTION

# SECTION 233713 – DIFFUSERS AND GRILLES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Perforated grilles.
3. Fixed face registers and grilles.
4. Louvers

B. Related Sections:
1. Section 233300 "Air Duct Accessories" for fire dampers and volume-control dampers not integral to diffusers, registers, and grilles.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

## PART 2 - PRODUCTS

### 2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

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

a. A-J Manufacturing Co., Inc.
b. Anemostat Products; a Mestek company.
c. Carnes Company.
d. Hart & Cooley Inc.
e. Kees, Inc.
f. Krueger.
g. METALAIRE, Inc.

h. Nailor Industries Inc.
i. Price Industries.
j. Raymon-Donco.
k. Shoemaker Mfg. Co.
l. Titus.
m. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: Baked enamel, color selected by Architect.
5. Face Style: Plaque.
6. Pattern: Adjustable.

B. Perforated Grilles:

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

a. Air Research Diffuser Products, Inc.
b. A-J Manufacturing Co., Inc.
c. Anemostat Products; a Mestek company.
d. Carnes Company.
e. Hart & Cooley Inc.
f. Kees, Inc.
g. Krueger.
h. METALAIRE, Inc.
i. Nailor Industries Inc.
j. Price Industries.
k. Shoemaker Mfg. Co.
l. Titus.
m. Tuttle & Bailey.
n. Warren Technology.

2. Material: Steel backpan with aluminum face.
3. Finish: Baked enamel, color selected by Architect.
4. Face Style: Flush.

## 2.2 REGISTERS AND GRILLES

A. Fixed Face Register:

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

a. A-J Manufacturing Co., Inc.
b. Anemostat Products; a Mestek company.
c. Carnes Company.
d. Dayus Register & Grille Inc.
e. Hart & Cooley Inc.
f. Kees, Inc.
g. Krueger.
h. Nailor Industries Inc.
i. Price Industries.

j. Shoemaker Mfg. Co.
k. Titus.
l. Tuttle & Bailey.

2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Core Construction: Integral.
5. Damper Type: Adjustable opposed blade.

2.3 LOUVERS:

A. General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide louvers that exceed minimum free area, and don’t exceed maximum pressure drop of each type as listed in manufacturer's current data, complying with louver schedule.

C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.

D. Materials: Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners. Frame and blade thickness nominal .081 inch.

E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

F. Frame: Size and type as scheduled on drawings, nominal .081 inch wall thickness with caulking slots.

G. Blades: Extruded aluminum with nominal .081 inch wall thickness.

H. Finish: Mill finish with Kynar Enamel coating (color by Architect).

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

## 3.3 ADJUSTING

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

END OF SECTION 233713

# SECTION 26 0100 - BASIC ELECTRICAL REQUIREMENTS

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 26, 27 and 28.

### 1.02 SUMMARY

A. The Electrical Contractor (E.C.) is defined as responsible for all building electrical systems including cabling, power and raceways for systems provided by other contractors as indicated on the plans. This contractor is also responsible for low voltage wiring, raceways, devices/components/equipment and commissioning of Intrusion Detection System, Fire Alarm/Sprinkler Supervisory and Data Communications Systems.

B. The Security Contractor (S.C.) is defined as responsible for all devices, equipment and installation for Access Controls and Surveillance Systems. This work is to be performed by the owners vendor. Cabling, power, raceways and boxes is provided and installed by the Electrical Contractor.

C. Each contractor is responsible for reading and understanding this specification.

D. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:
   1. Quality Assurance.
   2. Submittals.
   3. Drawings and Specifications.
   4. Electronic Files.
   5. Project Closeout.
   6. Record Documents.
   7. Maintenance Manuals.
   8. Equipment and Systems Demonstration.
   9. Delivery, Storage, and Handling.
   10. Work Sequence.
   11. Use of Premises.
   12. Occupancy Requirements.
   13. Inspections, Permits, Fees and Regulations.
   14. Miscellaneous Provisions.
   15. Workmanship.

E. Related Sections: The following sections contain requirements that relate to this section:
   1. Division 23 Section "BASIC MECHANICAL MATERIALS AND METHODS," for factory-installed motors, controllers, accessories, and connections:
      a. Mechanical Contractor will provide a complete system to automatically control the heating, ventilating and air conditioning with all temperature control related equipment including interface wiring, etc. The Electrical Contractor shall make necessary power connections to the units shown on these plans.

b. Mechanical Contractor will also furnish and install the remote control wiring where it is part of the temperature control system including all necessary raceways in accordance with these Electrical Specifications.

2. Division 26 Section "BASIC ELECTRICAL MATERIALS AND METHODS," for materials and methods common to the remainder of Division 26.
3. Division 08 Section “Doors and Windows” for motors, controllers, accessories and connections:
   c. Furnish and install power wiring for the automatic powered door operators and as shown on the plans. Units will be furnished and installed complete with a prewired control package.
   d. Electrical remote control devices (i.e. pushbuttons, switches, etc.) will be furnished by the Equipment Supplier, but shall be installed and connected by the Electrical Contractor per recommendations of the Equipment Supplier. Field verify and coordinate rough-in and final installation details.
4. Division 10, 11, 12 and 13 Sections for other “Specialties,” “Equipment” and “Furnishing.”
   a. Furnish and install power and control wiring as required. Field verify and coordinate rough-in and final installation details.

F. Work by Others: All motors for building utility equipment will be furnished and installed under other Divisions of these specifications, but shall be connected by the Electrical Contractor under Division 26 Specifications.

## 1.03 QUALITY ASSURANCE

B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, generated heat output, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

C. Product Uniformity: In order to provide the owner with systems that are reasonably maintainable, the contractor shall make product selections to assure manufacturer uniformity in all cases possible. This includes, but is not limited to, lighting fixtures, wiring devices, motor control, wire/cable, etc.

## 1.04 SUBMITTALS

A. General: Follow the procedures specified in Division 01.

B. Submittals are generally categorized as follows:
   1. Test reports, inspections, and compliance data
   2. Product data
   3. Shop drawings
   4. Technical supporting data and calculations
   5. Maintenance, installation and trouble-shooting data
   6. Guarantees and Warranties

D. Refer to each individual section for specific submittal requirements. Incomplete submittals will not be accepted.

E. The required Product Data submittals shall be forwarded as complete informational documents suitable to describe the performance characteristics of the product being submitted. In no case shall the content of these submittals be less informative than the products detailed/scheduled/specified within the contract documents. Incomplete product data submittals, as determined by the reviewing engineer, will be returned to the submitting contractor marked "incomplete", requiring the contractor/vendor to re-examine the specified requirements of the submittal.

F. Product data submittals comprising of manufactured equipment whose name does not appear within the specified "list" of acceptable manufacturers will not be approved for use unless "officially" added to the list prior to the actual bidding date. There will be no exceptions.

G. Engineer's Action For Submittals
1. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.
2. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
   a. Final Unrestricted Release: Where submittals are marked "No Exception Taken," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
   b. Final-But-Restricted Release: When submittals are marked "Exception Taken as Noted," that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents, final acceptance will depend on that compliance.
   c. Return for Resubmittal: When submittal is marked "Not Approved, Review and Resubmit," do not proceed with the part of the Work covered by the submittals, including purchasing, fabrication, delivery or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark. Do not permit submittals marked "Not Approved, Revise and Resubmit" to be used at the Project Site, or elsewhere where Work is in progress.
      1) Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Action Not Required".
3. Distribution: Contractor shall furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.
   a. Do not proceed with installation until an applicable Scope of Product Data applicable is in the installer’s possession.
   b. Do not permit use of unmarked copies of Product Data in connection with construction.
4. Each copy is to be stamped approved by the contractor prior to submittal to the engineer.
5. Quantities are the responsibility of the contractor. In general, quantities will be marked out of the submittals by the Engineer if submitted.
6. Digital submissions are acceptable. Digital submission must be marked up by the submitter to show the exact capacity, options, etc. as the equipment will be released. Submittals without this information identified will be rejected.

1.05 DRAWINGS AND SPECIFICATIONS

A. Drawings indicate general arrangement of system and are to be followed insofar as possible. Deviations from drawings may be necessitated by field conditions. Detailed layouts of proposed departures to be submitted to Architect/Engineer for approval. Architect's/Engineer's written consent to change to be obtained before proceeding with work.

B. Drawings and Specifications to be considered cooperative and anything appearing in Specifications, but not on drawings, or vice versa, to be considered part of the Contract and to be executed.

C. Drawings indicate size and approximate location of various parts of work and to be used as general guide for installation. However, drawings are, to a considerable extent, diagrammatic and exact locations of conduit, boxes, etc., may appear on the drawings or must be worked out on job. However, no changes in sizes to be made without written approval of Architect/Engineer. Errors or omissions discovered by Bidding Contractors prior to bid openings, to be called to attention of Architect/Engineer without delay. Changes in plans or specifications resulting from such errors or omissions to be in effect only when corrected by Architect/Engineer by means of Addendum issued to all bidders prior to bid opening.

D. Comply with Architect's instructions for minor modifications in location of conduit, boxes, etc., to achieve effects desired by Architect.

E. If a specific item is specified or on drawings for multiple trades, this contractor shall include all items in the bid regardless of other trades. Resolution will be by Addendum or Change Order.

1.06 ELECTRONIC FILES

A. If the contractor chooses, MDA Engineering, Inc. will provide electronic files for the contractors convenience and use in the preparation of shop drawings and record drawings related to the project subject to the following terms and conditions:
   1. Background files of the building are to be supplied by Architect. Only plan files are available. No flow diagrams, details, schedules, riser diagrams, etc., are available.
   2. MDA Engineering, Inc. electronic files are compatible with AutoCAD. MDA Engineering, Inc. makes no representation as to the compatibility of these files with the contractors hardware or the contractors software beyond the specified release of the referenced specifications.
   3. Data contained on these electronic files is part of MDA Engineering, Inc. instruments of service and shall not be used by the contractor or anyone else receiving this data through or from the contractor for any purpose other than as a convenience in the preparation of shop drawings for the referenced project. Any other use or reuse by the contractor or by others, will be at the contractor's sole risk and without liability or legal exposure to MDA Engineering, Inc., and Owner. The contractors agree to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against MDA Engineering, Inc., and Owner, its officers, directors, employees, agents or sub-consultants which may arise out of or in connection with your use of the electronic files.
   4. The contractors shall, to the fullest extent permitted by law, indemnify and hold harmless MDA Engineering, Inc. from all claims, damages, losses and expenses, including attorney's fees arising out of or resulting from your use of these electronic files.

5. These electronic files are NOT contract documents. Significant differences may exist between these electronic files and corresponding hard copy contract documents due to addenda, change orders or other revisions. MDA Engineering, Inc. makes no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the signed contract documents prepared by MDA Engineering, Inc. and electronic files, the signed contract documents shall govern. The contractor is responsible for determining if any conflict exists. By the use of these electronic files, the contractor is not relieved of their duty to fully comply with the contract documents, including and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, verify field conditions and coordinate the work with that of other contractors for the project.
6. Because of the potential that the information presented on the electronic files can be modified, unintentionally or otherwise, MDA Engineering, Inc. reserves the right to remove all indication of ownership and/or involvement from each electronic display.
7. MDA Engineering, Inc. will furnish the contractor electronic files of drawing sheets specifically requested in writing by the contractor. The reference background files must be obtained from the Architect.
8. A CADD contract shall be signed by an officer of the contracting company prior to delivery of the electronic files.
9. Under no circumstances shall delivery of the electronic files for use by the contractor be deemed a sale by MDA Engineering, Inc. and MDA Engineering, Inc. makes no warranties, either express or implied, of merchantability and fitness for any particular purpose. In no event shall MDA Engineering, Inc. be liable for any loss of profit or any consequential damages.

## 1.07 PROJECT CLOSEOUT

A. In order to achieve a complete and commissioned project, each contractor is responsible for the following items:
   1. Final Inspection Certificates (Electrical and Fire Alarm).
   2. As-Built Drawings.
   3. Final Payment Request.
   4. Waiver of Liens.
   5. Demonstration Certificates signed by Owner.
   6. Delivery of extra materials with receipt signed by Owner.
   7. Return of Borrowed Keys and Working Permits.
   8. Letter Declaring Punch List Items Completed.
   9. Operation and Maintenance Manuals.
   10. Final guarantee and execution of warranties.

## 1.08 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:
   1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

B. Record drawings must be kept by each prime contractor as up-to-date as-built drawings during the course of the project. Failure to display up-to-date as-builts on a monthly basis may result in partial payment requests being delayed/denied by the reviewing parties.

1.09 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassemble; aligning and adjusting instructions.
   4. Servicing instructions and lubrication charts and schedules.
   5. MSDS for each chemical compound used in electrical systems.
   6. A copy of each approved shop drawing submittal.
   7. A list of all equipment used on the project including Contractor’s purchase order numbers and suppliers name and address.

1.10 EQUIPMENT AND SYSTEMS DEMONSTRATION

A. Each Contractor is responsible for verifying the complete operation of the equipment and systems installed as a part of the work. After the Electrical Contractor is satisfied that the work meets the specified intents and sequences of operation, the contractor shall schedule, through the Construction Manager, a session during which all aspects of the work are explained to the Owner’s personnel and/or representatives.

B. This explanation session shall cover:
   1. Items in the Maintenance Manuals.
   2. Condition of the record drawings.
   3. Location of equipment, both exposed and concealed.
   4. Location of system control centers.
   5. General overview of systems operation.
   6. Items in need of specific attention.
   7. Emergency shutdown procedures.

C. Factory-authorized demonstrations are required from:
   1. Lighting control system manufacturer.
   2. Emergency power system manufacturer.
   3. Fire alarm/Sprinkler supervisory systems manufacturer.

D. The general overview of systems operation shall include:
   1. Electrical Maintenance Procedures.
   2. Comments on system accessibility.
   3. System shutdown and start-up procedures.
   4. Special warrantees and procedures.
   5. System programming changes and adjustments.

E. The intention of this specified item is for the Contractor to help the Owner understand the electrical systems in the facility. Those present shall include:
   1. Project Manager.
   2. Project Superintendent.
   3. Representative of each appropriate subcontractor.
   4. Factory-authorized personnel from the manufacturers of equipment/systems noted above.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Comply with the guidelines and restrictions set forth in the pre-construction meeting.

1.12 WORK SEQUENCE

A. The Work will be conducted with coordination of all Trades to provide the least possible interference to the activities of the Owner's personnel and to permit an orderly transfer of personnel and equipment to the new facilities.

B. The Work will be conducted under supervision of the contractor with observation by the Architect/Engineer. The schedule of work will be determined by collaboration between the Contractor and the Owner.

C. The Work included in this project shall be terminated in a way which will allow future work to be continued in an advantageous manner. An advantageous manner shall be one which provides adequate access and the means by which existing work is easily extended.

D. The Work will be conducted in a timely fashion to assure full service. Delivery and installation of the pre-purchased equipment shall be coordinated with all general, mechanical and electrical work to complete work on or before the scheduled completion date.

1.13 USE OF PREMISES

A. General: During the construction period the Contractor shall have full use of the premises for construction operations, including use of project site. The Contractor's use of the premises is limited only by the Owner's right to perform work or to retain other contractors on portions of the project.

B. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
   1. Limits: Confine constructions operations to the Project Contract Limits.
   2. Owner Occupancy: Allow for Owner occupancy of site.
   3. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner’s employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
      a. Schedule deliveries to minimize use of driveways and entrances.
      b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Removal of construction waste materials created by the methods employed by the Contractor(s) shall be the responsibility of the contractor(s). Dumping, burial, or burning of materials on the project site is not permitted.

1.14 OCCUPANCY REQUIREMENTS

A. Partial Owner Occupancy: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total work.
   1. Prior to partial Owner occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed.
   2. Architect/Project Manager will prepare a Certificate of Substantial Completion for each specific portion of the work to be occupied before Owner occupancy.
   3. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.
   4. Before partial Owner Occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will provide, operate, and maintain mechanical and electrical systems serving occupied portions of building.
   5. On occupancy, Owner will assume responsibility for maintenance service for occupied portions of building.

1.15 INSPECTIONS, PERMITS, FEES AND REGULATIONS

A. Each Contractor is responsible for submitting plans, paying fees, and organizing the required inspections to complete the Scope of Work. This includes, but is not limited to:
   1. Building Department Inspections/Department of Commerce.
   2. State Department Inspections.
   3. Local Fire Department or Authority Inspection.
   4. Owner’s Risk/Loss Insurer Inspections.

B. All work and material to be accordance with all local, state and federal laws, ordinances, rules and regulations relating to work and latest edition of National Electrical Codes, including amendments. Where drawings or specifications exceed legal requirements, the design shall govern. However, no work to be installed contrary to or below minimum legal standards.

C. Utility Company Backcharges:
   1. Contractor shall note that all utility company backcharges for the “Electrical Service,” “Telephone Service” and “CATV” Service as indicated on the plans will be paid direct by the Owner.
   2. Contractor shall, as part of his project scope, assist with utility company contact, coordination of service location, timing of service energization etc., without additional cost to the Owner.

1.16 MISCELLANEOUS PROVISIONS

A. Field Conditions: Since the Contract Documents do not contain full size scaled plans, the Contractor is responsible for reviewing and understanding all existing field conditions to perform the work described in these specifications. The Contractor shall refer to the schematics provided within the specifications, investigate the existing field conditions to the fullest extent possible, and provide all work as required for a full and complete installation, adhering to the scope of work and sequences within the Contractor Documents.

B. Each Contractor shall locate and inspect each item referenced as being part of existing building systems. Upon inspection, the Contractor is to verify that each intended integration of new system to old system can be accomplished. Any discrepancies, unforeseen incompatibilities, or malfunctioning existing building systems must be notified prior to bid acceptance.
   1. These items include, but are not limited to: branch circuiting and wiring devices, distribution panels and feeders, main service, lighting systems, fire alarm/supervisory systems, motor control, telecommunications, security, etc.

## 1.17 UNDERGROUND UTILITIES

A. Per Oregon Administrative Rules to provide procedures for identification of underground facilities:
   1. Each Contractor shall alert immediately the occupants of nearby premises as to any emergency that he may create or discover on or near such premises of the underground facility any break or leak on its lines or any dent, gouge, groove or other damage.

B. Prior to digging or drilling, Contractor shall contact the Oregon Utility Notification Center (OUNC) (800-332-2344) to have known utilities located and marked to avoid damage to existing underground utilities.

## 1.18 TEMPORARY ELECTRICAL

A. Temporary electrical utilities include, but are not limited to, the following:
   1. Electrical power service.
   2. Lighting.
   3. Telephone service.

B. General: Cost or use charges for temporary facilities are not chargeable to Owner or Architect/Engineer and shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, the following:
   1. Owner’s construction forces.
   2. Occupants of project.
   3. Architect/Engineer.
   4. Construction Manager.
   5. Project Manager.
   6. Testing agencies.
   7. Personnel of authorities having jurisdiction.

C. Electric Power Service: Pay electric power service use charges, whether metered or otherwise, for electricity used by all entities engaged in construction activities at Project site.

D. Temporary Utilities: At earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of permanent service.
   1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance and protection of each permanent service during its use as a construction facility before Owner’s acceptance, regardless of previously assigned responsibilities.

E. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the work:
   1. Keep temporary services and facilities clean and neat.
   2. Relocate temporary services and facilities as required by progress of the work.

F. Electrical Outlets: properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into high-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.

G. Power Distribution System Circuits: Where permitted and overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. All work shall be performed by workers skilled in the particular trade involved and shall be done in a neat, workmanlike manner, up to present standards and practices.

B. Unless specified otherwise, all materials shall be new and both workmanship and materials shall be of good quality.

C. The Contractor shall have in charge of the work at all times during construction a competent foreman or superintendent, experienced in the work to be installed under this division of the work and with previous experience as a foreman for the Contractor.

3.02 TEMPORARY ELECTRICAL UTILITIES INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the work. Relocate and modify facilities as required.

B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.03 TEMPORARY UTILITY INSTALLATION

A. General: Engage appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
   2. Provide adequate capacity at each stage of construction. Before temporary utility is available, provide trucked-in services.
   3. Obtain easements to bring temporary utilities to Project site where Owner’s easements cannot be used for that purpose.

B. Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnecting means, automatic ground-fault interrupters, and main distribution switchgear.
   1. Install electric power service underground, unless overhead service must be used.
   2. Install power distribution wiring overhead and rise vertically where least exposed to damage.
   3. Connect temporary service to Owner's existing power source, as directed by electric company officials.

C. Electric Power Service: Use of Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to Owner.

D. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and equipment.
   1. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
   2. Provide warning signs at power outlets other than 110 to 120 V.
   3. Provide metal conduit, tubing, or metallic cable for wiring exposed to possible damage. Provide rigid steel conduits for wiring exposed on grades, floors, decks, or other traffic areas.
   4. Provide metal conduit enclosures or boxes for wiring devices.
   5. Provide 4-gang outlets, spaced so 100-foot extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.

E. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
   2. Provide one 100-W incandescent lamp per 500 sq. ft., uniformly distributed, for general lighting, or equivalent illumination.
   3. Provide one 100-W incandescent lamp every 50 feet in traffic areas.
   4. Provide one 100-W incandescent lamp per story in stairways and ladder runs, located to illuminate each landing and flight.
   5. Install exterior-yard site lighting that will provide adequate illumination for construction operations, traffic conditions, and signage visibility when the Work is being performed.
   6. Install lighting for Project identification sign.

F. Telephone Service: Provide temporary telephone service throughout construction period for common-use facilities used by all personnel engaged in construction activities. Install separate telephone line for each field office and first-aid station.
   1. Provide additional telephone lines for the following:
      a. In field office with more than two occupants, install a telephone for each additional occupant or pair of occupants.
      b. Provide a dedicated telephone line for each facsimile machine and computer with modem in each field office.
      c. Delete subparagraph below if Owner maintains a separate on-site field office.
      d. Provide a separate telephone line for Owner's use.
      e. Delete subparagraph below if not required.
      f. Install a telephone on every second or third story of construction.
   2. At each telephone, post a list of important telephone numbers.
      a. Police and fire departments.
      b. Ambulance service.
      c. Contractor's home office.
      d. Architect's office.
      e. Engineers' offices.
      f. Owner's office.
      g. Principal subcontractors' field and home offices.
   3. Provide voice-mail service on superintendent's telephone.

END OF SECTION 26 0100

# SECTION 26 0500 - BASIC ELECTRICAL MATERIALS AND METHODS

## 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.

B. Related Sections:
   1. Division 03 Section “Cast-In-Place Concrete.”
   2. Division 09 Section “Painting.”
   3. Division 26 Section “Basic Electrical Requirements.”

### 1.02 SUMMARY

A. This Section includes the following electrical materials and methods:
   1. Concrete equipment bases.
   2. Firestopping.
   3. Access panels and doors.
   4. Nonshrink grouting for equipment installations.
   5. Rough-in.
   6. Cutting and Patching.
   7. Refinishing and Touchup Painting.
   8. Cleaning and Protection.

### 1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces mechanical and electrical equipment rooms, and plant areas.

C. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, furred spaces and duct shafts.

E. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

### 1.04 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data for each type of product specified.
   1. Electrical sleeve seals.
   2. Fire barrier penetration sealants.

3. Access doors.

C. Shop Drawings detailing fabrication and installation of supports and anchorage for electrical items.
   1. Dimensioned plans and sections or elevation layouts of electricity-metering equipment.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70 for components and installation.

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

C. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.06 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the work. Coordinate installing large equipment requiring positioning before closing in the building.

C. Through-Penetration Firestop Systems
   1. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
   2. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
   3. Notify Architect/Engineer inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
   4. Do not cover up through-penetration firestop system installation that will become concealed behind other construction until Owner’s inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

D. Coordinate electrical service connections to components furnished by utility companies.
   1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified herein.

F. Coordinate with General Contractor protection of electrical work and equipment from painting, concrete and similar trade work.

## PART 2 - PRODUCTS

### 2.01 FIRE STOPPING MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Firestop Systems, Inc.
2. Hilti Construction Chemicals, Inc.
3. Nelson Firestop Products.
4. 3M Fire Protection Products.
5. Tremco.
6. United States Gypsum Company.
7. I.P.C.

### 2.02 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As specified in Division 03 Section "Cast-in-Place Concrete." All exposed edges shall be formed with ¾" chamfer.

B. Concrete: 3000-psi, 28-day compressive strength as specified in Division 03 Section "Cast-in-Place Concrete."

### 2.03 ACCESS DOORS

A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

B. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

C. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

D. Locking Devices: Flush, screwdriver-operated cam locks; or where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

## PART 3 - EXECUTION

### 3.01 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to building structure and other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

## 3.02 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

B. Pipe or duct penetrations through all floors, fire walls or rated ceilings shall be sealed to prevent spread of fire and smoke and ingress of moisture. Seals shall be properly closed using U.L. Listed Products to match the penetration firestop system designation. Materials shall be free of asbestos, dangerous solvents, non-halogenated and shall not produce toxic fumes or smoke during exposure to fire. Fire stop shall be designed and installed to equal or exceed the fire resistance rating of the wall or floor.

C. Fill areas around conduits or sleeves with a dielectric, non-hardening putty or expanding caulk materials.

D. Seal large openings in floors or masonry walls using light weight, low density expanding mortar.

E. Seal large openings around bus ducts or cable trays where passing through fire rated walls using fire seal bags stuffed into the opening. Bags shall be coated fiberglass, conformable and shall be easily removable and re-useable for retrofit applications.

## 3.03 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer’s anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated.

B. Edges shall be tooled as a minimum, or chamfered when indicated on the drawings. Grout rough spots where directed. Finished surfaces shall be smooth.

## 3.04 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

## 3.05 GROUTING

A. Install nonmetallic nonshrink grout for electrical equipment base bearing surfaces, light pole and other equipment base plates, and anchors. Mix grout according to manufacturer’s printed instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms for placement of grout, as required.

D. Avoid air entrapment when placing grout.

E. Place grout to completely fill equipment bases.

F. Place grout on concrete bases to provide a smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's printed instructions.

3.06 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 02 through 28 for rough-in requirements.

C. Coordinate all electrical installations with mechanical locations prior to executing the work. Install raceway and equipment to avoid interfering with mechanical ductwork and piping.

3.07 CUTTING PATCHING

A. General: Perform cutting and patching in accordance with Division 01. In addition to the requirements specified in Division 01, the following requirements apply:
   1. Protection of Installed Work: During cutting and patching operations, protect and patching of electrical.

B. Perform cutting, fitting, and patching of electrical equipment and materials required to:
   1. Uncover Work to provide for installation of ill-timed Work.
   2. Remove and replace defective Work.
   3. Remove and replace Work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed Work as specified for testing.
   5. Install equipment and materials in existing structures.
   6. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for observation of concealed Work.

C. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of fixtures, wiring devices, outlet boxes, conduit, wire panels and other electrical items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
   1. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
   2. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

F. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved. Patch all damaged surfaces ready for final finishes by General Contractor.

3.08 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 Section “Painting.”

B. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

C. Follow paint manufacturer’s written instructions for surface preparation and for timing and application of successive coats.

D. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

E. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.09 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

C. Remove shipping stickers and labels. Wipe cabinets clean free of adhesive.

END OF SECTION 26 0500

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

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
1. Copper building wire.
2. Aluminum building wire.
3. Metal-clad cable, Type MC.
4. Fire-alarm wire and cable.
5. Connectors and splices.

B. Related Requirements:
1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
2. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
3. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

### 1.02 ACTION SUBMITTALS

A. Product Data:
1. Copper building wire.
2. Aluminum building wire.
3. Metal-clad cable, Type MC.
4. Fire-alarm wire and cable.
5. Connectors and splices.

## PART 2 - PRODUCTS

### 2.01 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alpha Wire; brand of Belden, Inc.
2. Belden Inc.
3. Encore Wire Corporation.
4. General Cable; Prysmian Group North America.
5. Okonite Company (The).
6. Southwire Company, LLC.

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:
   1. Type THHN and Type THWN-2. Comply with UL 83.
   2. Type XHHW-2. Comply with UL 44.

2.02 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alpha Wire; brand of Belden, Inc.
   2. Belden Inc.
   3. Encore Wire Corporation.
   4. General Cable; Prysmian Group North America.
   5. Okonite Company (The).
   6. Southwire Company, LLC.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.

E. Conductor Insulation:
   1. Type XHHW-2. Comply with UL 44.

2.03 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems; Atkore International.
   2. Alpha Wire; brand of Belden, Inc.
   3. Belden Inc.
   4. Encore Wire Corporation.
   5. General Cable; Prysmian Group North America.
   6. Okonite Company (The).
   7. Southwire Company, LLC.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Comply with UL 1569.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:
   1. Single circuit.
   2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

F. Minimum Requirements:
   1. MC cables shall contain a separate insulated equipment grounding conductor.
   2. MC cables shall utilize stranded copper conductors for all phase, neutral and ground conductors.
   3. MC cables may not be used where visible/exposed in finished spaces. (i.e. where ceiling clouds are utilized and structure is exposed above and to the sides.
   4. MC cables may not be used in exposed areas below ceiling structure.
   5. MC cables shall be installed, supported and secured in accordance with NFPA 70.

G. Conductor Insulation:
   1. Type TFN/THHN/THWN-2. Comply with UL 83.
   2. Type XHHW-2. Comply with UL 44.

H. Armor: Steel or Aluminum, interlocked.

I. Jacket: PVC applied over armor.

## 2.04 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Wire & Cable Inc.
   2. CommScope, Inc.
   3. Comtran Corporation.
   4. Genesis Cable Products; Honeywell International, Inc.
   5. PYROTENAX; brand of nVent Electrical plc.
   6. Prysmian Cables and Systems; Prysmian Group North America.
   7. Radix Wire.
   8. Rockbestos-Suprenant Cable Corp.
   9. Superior Essex Inc.; subsidiary of LS Corp.
   10. West Penn Wire; brand of Belden, Inc.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
   2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

2.05 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M Electrical Products.
2. ABB, Electrification Business.
3. AFC Cable Systems; Atkore International.
4. Gardner Bender.
5. Hubbell Utility Solutions; Hubbell Incorporated.
6. ILSCO.
7. Ideal Industries, Inc.
8. NSi Industries LLC.
9. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
10. Service Wire Co.
11. TE Connectivity Ltd.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Copper or Aluminum.
2. Type: One or Two hole with standard or long barrels.
3. Termination: Compression or Crimp.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:
1. Copper for feeders smaller than No. 6 AWG; copper or aluminum for feeders No. 6 AWG and larger. Conductors shall be stranded.

B. Branch Circuits:
1. Copper. Solid for No. 16AWG and smaller; stranded for No. 14 AWG and larger.

C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Feeders: No. 2 AWG and smaller Type THHN/THWN-2, single conductors in raceway; No. 1 AWG and larger Type XHHW-2, single conductors in raceway.

C. Branch Circuits: No. 2 AWG and smaller Type THHN/THWN-2, single conductors in raceway; No. 1 AWG and larger Type XHHW-2, single conductors in raceway. Minimum conductor size shall be No. 12 AWG.

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.03 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points in accordance with Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.04 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

A. Comply with NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 260533 "Raceways and Boxes for Electrical Systems."
   1. It is acceptable to utilize open type plenum cable where installed concealed above accessible ceilings and in open areas above the bottom cord of steel, parallel and perpendicular to the building structure on j-hooks or bridle rings.
   2. Wiring in Transfer station and load out areas to be in conduit.
   3. Install plenum cable in environmental airspaces, including plenum ceilings.
   4. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.
   5. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
   6. Signaling Line Circuits: Power-limited fire-alarm cables shall not be installed in the same cable or pathway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

F. Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

## 3.05 CONNECTIONS

A. 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.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.

D. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

## 3.06 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

## 3.07 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## 3.08 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

## 3.09 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. Perform each of the following visual and electrical tests:
      a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
      b. Test bolted connections for high resistance using one of the following:
         1) A low-resistance ohmmeter.
         2) Calibrated torque wrench.
         3) Thermographic survey.
      c. Inspect compression-applied connectors for correct cable match and indentation.
      d. Inspect for correct identification.

e. Inspect cable jacket and condition.
f. Continuity test on each conductor and cable.
g. Uniform resistance of parallel conductors.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:
1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 0519

# SECTION 26 0523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

## 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. Low-voltage control cabling.
   2. Control-circuit conductors.
   3. Identification products.

### 1.03 COORDINATION

A. The contractor shall review all equipment shop drawings and wiring diagrams. The contractor shall verify that all the equipment information matches what is being required on the contract documents and make any necessary adjustments. If there are discrepancies the contractor shall notify the Construction Manager.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

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. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
   1. Flame Travel Distance: 60 inches or less.
   2. Peak Optical Smoke Density: 0.5 or less.
   3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

### 2.02 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

B. Painting: Paint plywood on all sides and edges with flat white paint.

2.03 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.
   1. One or Multi-pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One or Multi-pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

2.04 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

2.05 SOURCE QUALITY CONTROL

A. Cable will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
   1. Outlet boxes for cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
   2. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering the room from overhead.
   4. Extend conduits 3 inches above finished floor.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

## 3.02 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with TIA standards.
   2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   3. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
   4. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
   5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
   8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
   9. Pulling Cable: Monitor cable pull tensions.
   10. Support: Do not allow cables to lie on removable ceiling tiles.
   11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
   12. Provide strain relief.
   13. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
   14. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Installation of Control-Circuit Conductors:
   1. Install wiring in raceways.
   2. Use insulated spade lugs for wire and cable connection to screw terminals.
   3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
   3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

E. Separation from EMI Sources:
   1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
   2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
      c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
   3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
      b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
      c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
   4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
   5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

## 3.03 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

## 3.04 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits; No 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

## 3.05 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

3.06 GROUNDING

A. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.07 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 0523

# SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## 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 grounding and bonding systems and equipment.

### 1.03 ACTION SUBMITTALS

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

### 1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

### 1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

## 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 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Burndy; Part of Hubbell Electrical Systems.
   2. Dossert; AFL Telecommunications LLC.
   3. ERICO International Corporation.
   4. Fushi Copperweld Inc.
   5. Galvan Industries, Inc.; Electrical Products Division, LLC.
   6. Harger Lightning & Grounding.
   7. ILSCO.
   8. O-Z/Gedney; a brand of Emerson Industrial Automation.
   9. Siemens Industry, Inc., Energy Management Division.
   10. Thomas & Betts Corporation; A Member of the ABB Group.

2.03 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B3.
   2. Stranded Conductors: ASTM B8.
   3. Tinned Conductors: ASTM B33.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.04 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy. Exothermic for underground.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Ground Rod Connections: Exothermic-welded connection.

H. Water Pipe Clamps:
   1. Mechanical type, two pieces with stainless-steel bolts.
      a. Material: Tin-plated aluminum.
      b. Listed for direct burial.
   2. U-bolt type with malleable-iron clamp and copper ground connector.

2.05 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
   1. Bury at least 30 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

## 3.02 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

## 3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

## 3.04 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.05 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

E. Metallic Fences: Comply with requirements of IEEE C2.
   1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
   2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
   3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.06 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. Use exothermic welds for all below-grade connections.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
   1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at each column indicated.

H. 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 AWG.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor 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.

I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

J. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

## 3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:
    1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
    2. Substations and Pad-Mounted Equipment: 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

# SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Support, anchorage, and attachment components.
   2. Fabricated metal equipment support assemblies.

### 1.02 ACTION SUBMITTALS

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

### 1.03 INFORMATIONAL SUBMITTALS

A. Welding certificates.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame Rating: Class 1.
   2. Self-extinguishing according to ASTM D635.

### 2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB, Electrification Business.
      b. Allied Tube & Conduit; Atkore International.
      c. CADDY; brand of nVent Electrical plc.
      d. Cooper B-line; brand of Eaton, Electrical Sector.
      e. Flex-Strut Inc.
      f. G-Strut.

g. Gripple Inc.
h. Haydon Corporation.
i. MIRO Industries.
j. Metal Ties Innovation.
k. Rocket Rack; Robroy Industries.
l. Unistrut; Atkore International.
m. Wesanco, Inc.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel (outdoors and in Open Transfer area) Plain steel all other locations.
4. Channel Width: Selected for applicable load criteria.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Hilti, Inc.
2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Cooper B-line; brand of Eaton, Electrical Sector.
2) Empire Industries, Inc.
3) Hilti, Inc.
4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.

6. Toggle Bolts: All steel springhead type.
7. Hanger Rods: Threaded steel.

2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
1. NECA NEIS 101
2. NECA NEIS 102.
3. NECA NEIS 105.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.02 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT IMC and RMC may be supported by openings through structure members, in accordance with NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
   6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

## 3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

## 3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 4000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

A. Touchup:
   1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
      a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
   2. Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 0529

# SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## 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. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Nonmetal wireways and auxiliary gutters.
   5. Surface raceways.
   6. Boxes, enclosures, and cabinets.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
   2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

### 1.03 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

### 1.04 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## PART 2 - PRODUCTS

### 2.01 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AFC Cable Systems; a part of Atkore International.
      b. Allied Tube & Conduit; a part of Atkore International.
      c. Anamet Electrical, Inc.
      d. Calconduit.
      e. Electri-Flex Company.

f. FSR Inc.
g. Korkap.
h. NEC, Inc.
i. Opti-Com Manufacturing Network, Inc (OMNI).
j. O-Z/Gedney; a brand of Emerson Industrial Automation.
k. Patriot Aluminum Products, LLC.
l. Perma-Cote.
m. Picoma Industries, Inc.
n. Plasti-Bond.
o. Republic Conduit.
p. Southwire Company.
q. Thomas & Betts Corporation; A Member of the ABB Group.
r. Topaz Electric; a division of Topaz Lighting Corp.
s. Western Tube and Conduit Corporation.
t. Wheatland Tube Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. EMT: Comply with ANSI C80.3 and UL 797.
6. FMC: Comply with UL 1; zinc-coated steel or aluminum.
7. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFC Cable Systems; a part of Atkore International.
b. Allied Tube & Conduit; a part of Atkore International.
c. Anamet Electrical, Inc.
d. Calconduit.
e. Electri-Flex Company.
f. FSR Inc.
g. Korkap.
h. NEC, Inc.
i. NewBasis.
j. Opti-Com Manufacturing Network, Inc (OMNI).
k. O-Z/Gedney; a brand of Emerson Industrial Automation.
l. Patriot Aluminum Products, LLC.
m. Perma-Cote.
n. Picoma Industries, Inc.
o. Plasti-Bond.
p. Republic Conduit.
q. Southwire Company.
r. Thomas & Betts Corporation; A Member of the ABB Group.
s. Topaz Electric; a division of Topaz Lighting Corp.
t. Western Tube and Conduit Corporation.
u. Wheatland Tube Company.
2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.

6. Fittings for EMT:
   a. Material: Steel.
   b. Type: Setscrew or compression.
7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.02 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AFC Cable Systems; a part of Atkore International.
   b. Anamet Electrical, Inc.
   c. Arnco Corporation.
   d. CANTEX INC.
   e. CertainTeed Corporation.
   f. Champion Fiberglass, Inc.
   g. Condux International, Inc.
   h. Electri-Flex Company.
   i. FRE Composites.
   j. Kraloy.
   k. Lamson & Sessions.
   l. Niedax Inc.
   m. RACO; Hubbell.
   n. Thomas & Betts Corporation; A Member of the ABB Group.
   o. Topaz Electric; a division of Topaz Lighting Corp.
   p. United Fiberglass.
2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fiberglass:
   a. Comply with NEMA TC 14.
   b. Comply with UL 2515 for aboveground raceways.
   c. Comply with UL 2420 for belowground raceways.
4. ENT: Comply with NEMA TC 13 and UL 1653.
5. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
6. LFNC: Comply with UL 1660.
7. Rigid HDPE: Comply with UL 651A.
8. Continuous HDPE: Comply with UL 651A.
9. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
10. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AFC Cable Systems; a part of Atkore International.
      b. Anamet Electrical, Inc.
      c. Arnco Corporation.
      d. CANTEX INC.
      e. CertainTeed Corporation.
      f. Champion Fiberglass, Inc.
      g. Condux International, Inc.
      h. Electri-Flex Company.
      i. FRE Composites.
      j. Kraloy.
      k. Lamson & Sessions.
      l. Niedax Inc.
      m. RACO; Hubbell.
      n. Thomas & Betts Corporation; A Member of the ABB Group.
      o. Topaz Electric; a division of Topaz Lighting Corp.
      p. United Fiberglass.
   2. Fittings, General: Listed and labeled for type of conduit, location, and use.
   3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
      a. Fittings for LFNC: Comply with UL 514B.
   4. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-line, an Eaton business.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. MonoSystems, Inc.
   4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.04 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Adalet.
2. Crouse-Hinds, an Eaton business.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a brand of Pentair Equipment Protection.
7. Hubbell Incorporated.
8. Hubbell Incorporated; Wiring Device-Kellems.
9. Kraloy.
10. Milbank Manufacturing Co.
11. MonoSystems, Inc.
12. Oldcastle Enclosure Solutions.
13. O-Z/Gedney; a brand of Emerson Industrial Automation.
14. Plasti-Bond.
15. RACO; Hubbell.
16. Spring City Electrical Manufacturing Company.
17. Stahlin Non-Metallic Enclosures.
18. Thomas & Betts Corporation; A Member of the ABB Group.
19. Topaz Electric; a division of Topaz Lighting Corp.
20. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:
1. Material: sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Gangable boxes are prohibited.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 indoors, Type 3R outdoors with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

## PART 3 - EXECUTION

### 3.01 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: GRC.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
      a. Transfer Station and load out areas. All conduits in these areas regardless of mounting height/location to be GRC.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: GRC.
   7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings. Surface raceways “Wiremold” or equal is prohibited.

3.02 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Stub-Ups to Above Recessed Ceilings:
   1. Use EMT for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Conduit extending from interior to exterior of building.
   4. Conduit extending into pressurized duct and equipment.
   5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
   6. Where otherwise required by NFPA 70.

W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

X. Expansion-Joint Fittings:
   1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
   2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

CC. Locate boxes so that cover or plate will not span different building finishes.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set metal floor boxes level and flush with finished floor surface.

GG. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install 0sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.04 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.05 PROTECTION

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

END OF SECTION 26 0533

# SECTION 26 0543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

## 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. Direct-buried conduit, ducts, and duct accessories.
   2. Concrete-encased conduit, ducts, and duct accessories.
   3. Polymer concrete handholes and boxes with polymer concrete cover.

### 1.03 DEFINITIONS

A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

B. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

C. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

D. Duct Bank:
   1. Two or more ducts installed in parallel, with or without additional casing materials.
   2. Multiple duct banks.

E. GRC: Galvanized rigid (steel) conduit.

### 1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include duct-bank materials, including separators and miscellaneous components.
   2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Include accessories for handholes, boxes, and other utility structures.
   4. Include underground-line warning tape.

B. Shop Drawings:
   1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
      a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
      b. Include duct entry provisions, including locations and duct sizes.
      c. Include cover design.
      d. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

### 1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

B. Source quality-control reports.

C. Field quality-control reports.

1.06 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Construction Manager no fewer than two weeks in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

B. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

A. Comply with ANSI C2.

2.02 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.03 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ARNCO Corp.
   2. Beck Manufacturing.
   3. CANTEX INC.
   4. CertainTeed Corporation.
   5. Condux International, Inc.
   6. ElecSys, Inc.
   7. Electri-Flex Company.
   8. IPEX USA LLC.
   9. Lamson & Sessions.
   10. Manhattan/CDT.
   11. Spiraduct/AFC Cable Systems, Inc.

B. Duct Accessories:
   1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
   2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.04 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
   1. Color: Gray.
   2. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, As indicated for each service.
   6. Handholes 24 inches wide by 30 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armorcast Products Company.
      b. NewBasis.
      c. Quazite: Hubbell Power Systems, Inc.
      d. Oldcastle Precast

2.05 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Construction Manager if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Engineer.

C. Refer to Civil Drawings for specifications and requirements relating to “General Notes”, “Earthwork” and “General Utility Notes”.

3.02 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables More than 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less and Communications: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

D. Stub-ups: Concrete-encased GRC.

3.03 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less and Communications:
   1. Units in Driveway, Parking Lot, Off-Roadway and Turf Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating. Unless otherwise noted on the drawings.
   2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating. Unless otherwise noted on the drawings.
   3. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
   4. Cover design load shall not exceed the design load of the handhole or box.

3.04 EARTHWORK

A. Excavation and Backfill: Comply with Civil Drawings and specifications, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Civil Drawings specification sheet “General Notes”.

3.05 DUCT INSTALLATION

A. Install ducts according to NEMA TCB 2.

B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
   1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

E. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.

F. Duct Entrances in Buildings: Conduits entering buildings from below grade must extend 10" above finished floor and be GRC. Provide a 3 ½" high housekeeping pad around conduits at floor level.

G. Duct Terminations at Utility Poles: Conduit must extend 12" above finished grade (Communications Ducts) and up pole fully (Medium Voltage) and be RGS conduit where exposed.

H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

I. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.

J. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Excavate trench bottom to provide firm and uniform support for duct bank.
   2. Width: Excavate trench 3 inches wider than duct bank on each side.
   3. Depth: Install top of duct bank 42 inches below finished grade unless otherwise indicated.
   4. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
   5. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   6. Elbows: Use manufactured rigid steel conduit elbows (long sweep, 48 inch radius minimum) for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
      b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
   7. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
   8. Concrete Cover: Install a minimum of 3 inches of concrete cover at top and bottom, and a minimum of 3 inches on each side of duct bank.
   9. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
      b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

10. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

K. Direct-Buried Duct Banks:
1. Excavate trench bottom to provide firm and uniform support for duct bank.
2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
3. Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
4. Depth: Install top of duct bank at least 42 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Install manufactured rigid steel conduit elbows (long sweep, 48inch radius minimum) for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
7. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with Civil Drawings and specifications for installation of backfill materials.

L. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

## 3.06 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line.

E. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

## 3.07 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest. Test shall be performed in the presence of the Engineer and Construction Manager, notify each one week in advance of when test will be performed.
   3. Provide written test report indicating ducts have been tested and are free of defects, obstructions and are suitable for cable installation.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

## 3.08 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.

END OF SECTION 26 0543

# SECTION 26 0544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

## 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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.01 SLEEVES

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

### 2.02 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.04 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

D. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

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

3.03 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 0544

# SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## 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. Color and legend requirements for conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2].

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### 2.02 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:
1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
   1. Color shall be factory applied.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
   3. Colors for 240-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
   4. Colors for 480/277-V Circuits:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
   5. Color for Neutral: White or gray.
   6. Color for Equipment Grounds: Green.
   7. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Warning Label Colors:
   1. Identify system voltage with black letters on an orange background.

D. Warning labels and signs shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

E. Equipment Identification Labels:
   1. Black letters on a white field.

## 2.03 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted or Write-on, 3-mil- thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.
   1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
   2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
   1. Minimum Nominal Size:
      a. 1-1/2 by 6 inches for raceway and conductors
      b. 3-1/2 by 5 inches for equipment.
      c. As required by authorities having jurisdiction.

2.04 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.05 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:
   1. Tape:
      a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
      b. Printing on tape shall be permanent and shall not be damaged by burial operations.
      c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
   2. Color and Printing:
      a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
      b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
      c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.06 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch or 0.023 inch thick, color-coded for phase and voltage level, with factory screened or printed permanent designations; punched for use with self-locking cable tie fastener.

C. Write-on Tags:
   1. Polyester Tags: 0.010 inch or 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.
   2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.07 SIGNS

A. Baked-Enamel Signs:
   1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:
   1. Engraved legend.
   2. Thickness:
      a. For signs up to 20 sq. in., minimum 1/16 inch thick.
      b. For signs larger than 20 sq. in., 1/8 inch thick.
      c. Engraved legend with black letters on white face.
      d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.08 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

## 2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.01 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### 3.02 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.

I. Fire Alarm Raceways:
   1. Accessible Fire alarm conduits and boxes shall be red.

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment.

L. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

M. Vinyl Wraparound Labels:
   1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
   2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

P. Self-Adhesive Labels:
   1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
   1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

W. Underground Line Warning Tape:
   1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
   2. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:
   1. Place in a location with high visibility and accessibility.
   2. Secure using cable ties.

Y. Nonmetallic Preprinted Tags:
   1. Place in a location with high visibility and accessibility.
   2. Secure using cable ties.

Z. Write-on Tags:
   1. Place in a location with high visibility and accessibility.
   2. Secure using cable ties.

AA. Baked-Enamel Signs:
   1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.

BB. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

CC. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.03 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 50 A and 120V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
2. "FIRE ALARM."

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use snap-around labels to identify the phase.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.

I. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

K. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
   1. Apply to exterior of door, cover, or other access.
   2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
      a. Power-transfer switches.
      b. Controls with external control power connections.

N. Arc Flash Warning Labeling: Self-adhesive labels.

O. Operating Instruction Signs: Self-adhesive labels

P. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

Q. Equipment Identification Labels:
   1. Indoor Equipment: Self-adhesive label, Laminated acrylic or melamine plastic sign.
   2. Outdoor Equipment: Laminated acrylic or melamine sign screwed to equipment.
   3. Equipment to Be Labeled:
      a. Identification labeling of some items listed below may be required by individual Sections or by NFPA 70.
      b. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive label.
      c. Enclosures and electrical cabinets.
      d. Access doors and panels for concealed electrical items.
      e. Switchboards.
      f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      g. Emergency system boxes and enclosures.
      h. Enclosed switches.
      i. Enclosed circuit breakers.
      j. Enclosed controllers.
      k. Variable-speed controllers.
      l. Push-button stations.
      m. Power-transfer equipment.
      n. Contactors.
      o. Remote-controlled switches, dimmer modules, and control devices.
      p. Power-generating units.
      q. Monitoring and control equipment.

END OF SECTION 26 0553

# SECTION 26 0943 - LIGHTING CONTROLS SYSTEM

## 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 a digital networked lighting control system comprised of the following components:
   1. System Software Interfaces
      a. Management Interface
      b. Historical Database and Analytics Interface
      c. Visualization Interface
      d. Personal Control Applications
      e. Smartphone Programming Interface
   2. System Backbone and Integration Equipment
      a. System Controller
   3. Wired Networked Devices
      a. Wall Stations
      b. Graphic Wall Stations
      c. Digital Key Switches
      d. Auxiliary Input/Output Devices
      e. Occupancy and Photocell Sensors
      f. Wall Switch Sensors
      g. Power Packs and Secondary Packs
      h. Relay and Dimming Panel
      i. Bluetooth® Low Energy Programming Device
      j. Communication Bridge
   4. Wireless Networked Devices
      a. Wireless Networked Auxiliary Fixture Control Devices.
      b. Wireless Networked Occupancy and Photosensors.
      c. Wireless Networked Embedded Sensors.
      d. Wireless Networked Power Packs

B. The networked lighting control system shall meet all of the characteristics and performance requirements specified herein.

C. The contractor shall provide, install and verify proper operation of all equipment necessary for proper operation of the system as specified herein and as shown on applicable drawings.

### 1.03 REFERENCES

A. Section 262726 Wiring Devices

B. Section 265119 LED Interior Lighting

C. Section 265213 Emergency and Exit Lighting

D. Section 265619 LED Exterior Lighting

1.04 ACTION SUBMITTALS

A. Submittal shall be provided including the following items.
   1. Bill of Materials necessary to install the networked lighting control system.
   2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
   3. Riser Diagrams showing device wiring connections of system backbone and typical per room/area type.
   4. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
   5. Other Diagrams and Operational Descriptions – as needed to indicate system operation or interaction with other system(s).
   6. Contractor Startup/Commissioning Worksheet.
   7. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.
   8. Hardware and Software Operation Manuals.

1.05 Quality Assurance

A. Product Qualifications
   1. System electrical components shall be listed or recognized by a nationally recognized testing laboratory (e.g., UL, ETL, or CSA) and shall be labeled with required markings as applicable.
   2. System shall be listed as qualified under DesignLights Consortium Networked Lighting Control System Specification V2.0.
   3. System luminaires and controls are certified by manufacturer to have been designed, manufactured and tested for interoperability.
   4. All components shall be subjected to 100% end of line testing prior to shipment to the project site to ensure proper device operation.
   5. All components and the manufacturing facility where product was manufactured must be RoHS compliant.

B. Installation and Startup Qualifications
   1. System startup shall be performed by qualified personnel approved or certified by the manufacturer.

C. Service and Support Requirements
   1. Phone Support: Toll free technical support shall be available.
   2. Remote Support: The bidder shall offer a remote support capability.
   3. Onsite Support: The bidder shall offer onsite support that is billable at whole day rates.
   4. Service Contract: The bidder shall offer a Service Contract that packages phone, remote, and onsite support calls for the project. Response times for each type of support call shall be indicated in the terms of the service contract included in the bid package.

1.06 Project Conditions

A. Only install equipment after the following site conditions are maintained:
   1. Ambient Temperature: 14 to 105 degrees F (-10 to 40 degrees C)
   2. Relative Humidity: less than 90% non-condensing

B. Equipment shall not be subjected to dust, debris, moisture, or temperature and humidity conditions exceeding the requirements indicated above, at any point prior to installation.

C. Only properly rated equipment and enclosures, installed per the manufacturer's instructions, may be subjected to dust and moisture following installation.

1.07 Warranty

A. The manufacturer shall provide a minimum five-year warranty on all hardware devices supplied and installed. Warranty coverage shall begin at substantial completion.

B. The hardware warranty shall cover repair or replacement any defective products within the warranty period.

1.08 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On USB drive and manufacturer's support website.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.

1.09 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lighting Control Relays: Equal to one percent of amount installed for each size indicated, but no fewer than ten.

B. The manufacturer shall make available to the owner new parts, upgrades, and/or replacements available for a minimum of 5 years following installation.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panels for installation according to NECA 407.

1.11 COORDINATION

A. Coordinate layout and installation of panels and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate the installation if the panels with the other electrical equipment and all other equipment to maintain code required clearances.

PART 2 - EQUIPMENT

2.01 Manufacturers

A. Acceptable Manufacturers
   1. Acuity Brands Lighting
   2. Crestron
   3. Wattstopper

B. Basis of Design System: Acuity Controls nLight

2.02 System Compliance

A. System components shall comply with UL 916 and UL 924 standards where applicable.

B. System components shall comply with CFR Title 47, Part 15 standards where applicable.

C. All equipment shall be installed and connected in compliance with NFPA 70.

2.03 System Performance Requirements

A. System Architecture
   1. System shall have an architecture that is based upon three main concepts: (1) networkable intelligent lighting control devices, (2) standalone lighting control zones using distributed intelligence, (3) optional system backbone for remote, time based and global operation between control zones.
   2. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.
   3. System must be capable of interfacing directly with networked luminaires such that either low voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches and system backbone (see Control Zone Characteristics sections for each type of network connection, wired or wireless).
   4. Lighting control zones consisting of one or more networked and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher-level system backbone; this capability is referred to as “distributed intelligence.”
      a. Lighting control zones (wired and wireless) of at least 128 devices per zone shall be supported.
   5. Lighting control zones shall be capable of being networked with a higher-level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software interface.
   6. The system may include one or more system controllers that provide time-based control and global system control across multiple control zones and backbone network segments. The system controller also provides a means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP or BACnet MS/TP protocol.

7. The system shall include “communication bridge” devices that route communication from lighting control zones to and from the system controller, for purposes of decreasing system wiring requirements.
8. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality at a later date.

B. Wired Networked Control Zone Characteristics
1. Connections to devices within a wired networked lighting control zone and to backbone components shall be with a single type of low voltage network cable, which shall be compliant with CAT6 specifications or higher. To prevent wiring errors and provide cost savings, the use of mixed types of low voltage network cables shall not be permitted.
2. Devices in an area may be connected via a “daisy-chain” topology; requiring all individual networked devices to be connected back to a central component.
3. System shall provide the option of having pre-terminated plenum rated low voltage network cabling supplied with hardware so as to reduce the opportunity for improper wiring and communication errors during system installation.
4. Once software is installed, system shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.
5. All networked devices shall have the ability to detect improper communication wiring and blink it’s LED in a specific cadence as to alert installation/startup personnel.
6. Networked control devices intended for control of egress and/or emergency light sources shall not require the use of additional, externally mounted UL924 shunting and/or 0-10V disconnect devices, so as to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:
    a. Low-Voltage power sensing: These devices shall automatically provide 100% light level upon detection of loss of power sensed via the low voltage network cable connection.
    b. UL924 Listed Line-Voltage power sensing: These devices shall be listed as emergency relays under the UL924 standard, and shall automatically close the load control relay and provide 100% light output upon detection of loss of power sensed via line voltage connection to normal power.

C. Wireless Networked Control Zone Characteristics
1. No wired connections between networked devices shall be required for the purposes of system communications.
2. Multiple wireless networking protocols shall be supported:
    a. A standards based, distributed star topology type of protocol for 900 MHz communication, so as to support lighting control applications and IoT applications.
    b. A Bluetooth standard protocol for 2.4 GHz communication that supports direct connection to a smartphone and tablet device, so as to support device configuration, control applications, and IoT without requiring the use of a system backbone.
3. Wireless network shall be self-healing, such that the loss of backbone or local communication between devices does not result in the loss of control of the lights in the space.
4. Wireless network communication shall support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.
5. To support the system architecture requirement for distributed intelligence, wireless network communication shall support communication of control signals from sensors and wall stations to networked luminaires and wireless load control devices, without requiring any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge or gateway.

6. All wireless communication between lighting control components shall support the following five tiers of security measures.
    a. Data Encryption
    b. Firmware Protection
    c. Tamper-Proof Hardware
    d. Authenticated User Access
    e. Mutual Device Authentication
7. Accounting for typical environmental conditions and building construction materials encountered within commercial indoor lighting environments, wireless networked devices shall be capable of communicating to at least 150’ spacing between devices with embedded wireless transceivers under typical site conditions.
8. Wireless networked devices shall have a line-of-sight communication range of at least 1000’ under ideal environmental conditions.

D. System Integration Capabilities
1. The system shall have the capability to integrate with a building automation system in the future.

E. Supported Sequence of Operations
1. Characteristics and performance requirements herein shall be supported by the networked lighting control system.
2. Control Zones
    a. Intelligent lighting control devices installed in an area (also referred to as a group of devices) shall be capable of transmitting and tracking occupancy sensor, photocell sensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within the area. These shall also be referred to as local control zones.
    b. Intelligent lighting control devices located in different areas shall be able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy and photocell commands shall be available across a single controller, and switch commands shall be available across single or multiple controllers. These shall also be referred to as global control zones.
3. Wall station Capabilities
    a. Wall stations shall be provided to support the following capabilities:
        1) On/Off of a local control zone and global control zone simultaneously, as required.
        2) Continuous dimming control of light level of a local control zone and global control zone simultaneously, as required.
        3) Preset Scenes that can activate a specific combination of light levels across multiple local and global channels, as required.
        4) Profile Scenes that can modify the sequence of operation for the devices in the area (group) in response to a button press. This capability is defined as supporting “Local Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage. Wall stations shall be able to manually start and stop Local Profiles, or the local profile shall be capable of ending after a specific duration of time between 5 minutes and 12 hours. Parameters that shall be configurable and assigned to a Local Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.

b. 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local and global control zones, so as to support “multi-way” switching, dimming, preset scene, and profile scene control.

4. Occupancy Sensing Capabilities
   a. Local and global control: Occupancy sensors shall be configurable to control a local and global zone simultaneously, as required.
   b. Multi-sensor control: multiple occupancy sensors shall be capable of controlling the same local and global control zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
   c. System shall support the following types of occupancy sensing sequence of operations:
      1) On/Off Occupancy Sensing
      2) Partial-On Occupancy Sensing
      3) Partial-Off Occupancy Sensing
      4) Vacancy Sensing (Manual-On / Automatic-Off)
   d. On/Off, Partial-On, and Partial-Off Occupancy Sensing modes shall function according to the following sequence of operation:
      1) Occupancy sensors shall automatically turn lights on to a designated level when occupancy is detected. To support fine tuning of Partial-On sequences the designated occupied light level shall support at least 100 dimming levels.
      2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels. To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.
      3) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under *Photocell Sensing Capabilities.*
      4) At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
   e. Vacancy Sensing mode (also referred to as Manual-On / Automatic-Off) shall function according to the following sequence of operation:
      1) The use of a wall station is required turn lights on. The system shall be capable of programming the zone to turn on to either to a designated light level or the previous user light level. Initially occupying the space without using a wall station shall not result in lights turning on.
      2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels. To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.

3) To minimize occupant impact in case the area or zone is still physically occupied following dimming or shutoff of the lights due to detection of vacancy, the system shall support an “automatic grace period” immediately following detection of vacancy, during which time any detected occupancy shall result in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.

4) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under *Photocell Sensing Capabilities.*

5) At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.

f. To accommodate different types of environments, occupancy time delays before dimming or shutting off lights shall be specifiable for control zones between 15 seconds to 2 hours.

5. Photocell Sensing Capabilities (Automatic Daylight Sensing)

a. Photocell sensing devices shall be configurable to control a local and global zone simultaneously, as required.

b. The system shall support the following types of photocell-based control:

1) On/Off: The control zone is automatically turned off if the photocell reading exceeds the defined set point and automatically turned on if the photocell reading is below the defined set point. An adjustable time delay or adaptive set point behavior may be used to prevent the system from exhibiting nuisance on/off switching, as well as a dead band to prevent on/off cycling.

2) Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell set point and dimming rates.

6. Schedule and Global Profile Capabilities

a. The system shall be capable of automatically modifying the sequence of operation for selected devices in response to any of the following: a time-of-day schedule, contact closure input state, manually triggered wall station input, RS-232/RS-485 command, and BACnet input command. This capability is defined as supporting “Global Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage.

b. Global profiles may be scheduled with the following capabilities:

1) Global Profiles shall be stored within and executed from the system controller (via internal timeclock) such that a dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.

2) Global Profile time of day schedules shall be capable of being given the following recurrence settings: daily, specific days of week, every “n” number of days, weekly, monthly, and yearly. Lighting control profile schedules shall support definition of start date, end date, end after “n” recurrences, or never ending. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

3) Global Profile Holiday Schedules should follow recurrent settings for specific US holiday dates regardless if they always occur on a specific date or are determined by the day/week of the month.

4) Global Profiles shall be capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
5) System shall support blink warning and timed extension capabilities. At the end of a scheduled period, the system shall be capable of providing a visible "blink warning" 5 minutes prior to the end of the schedule. Wall stations may be programmed to provide timed overrides that turn the lights on for an additional period of time. Timed override duration shall be programmable for each individual device, zone of devices, or customized group of devices, ranging from 5 minutes to 12 hours.
6) Software management interface shall be capable of displaying a graphic calendar view of profile schedules for each control zone.

c. System Global Profiles shall have the following additional capabilities:
1) Global Profiles shall be capable of being manually activated directly from the system controller, specially programmed input devices, scene capable wall stations, and the software management interface.
2) Global Profiles shall be selectable to apply to a single device, zone of devices, or customized group of devices.
3) Parameters that shall be configurable and assigned to a Global Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.

d. A backup of Local and Global Profiles shall be stored on the software's host server such that the Profile backup can be applied to a replacement system controller or wall station.

7. System shall support automated demand response capabilities with automatic reduction of light level to at least three levels of demand response.

2.04 System Software Interfaces

A. Management Interface
1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. Management interface shall require all users to login with a User Name and Password, and shall support creation of at least 100 unique user accounts.
4. Management interface shall support at least three permission levels for users: read-only, read & change settings, and full administrative system access.
5. Management interface shall be capable of restricting access for user accounts to specific devices within the system.
6. All system devices shall be capable of being given user-defined names.
7. The following device identification information shall be displayed in the Management interface: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
8. Management interface shall be able to read the live status of intelligent control device and shall be capable of displaying luminaire on/off status, dim level, power measurement, device temperature, PIR occupancy sensor status, microphonic occupancy sensor status, remaining occupancy time delay, photocell reading, and active Scenes or Profiles.

9. Management interface shall be able to read the current active settings of intelligent control device and shall be capable of displaying dimming trim levels, occupancy sensor and photocell enable/disable, occupancy sensor time delay and light level settings, occupancy sensor response (normal or vacancy), and photocell set points and transition time delays.
10. Management interface shall be able to change the current active settings and default settings for intelligent control device.
11. Management interface shall be capable of applying settings changes for a zone of devices or a group of selected devices using a single “save” action that does not require the user to save settings changes for each individual device.
12. A printable network inventory report shall be available via the management interface.
13. A printable report detailing all system profiles shall be available via the management interface.
14. All sensitive information stored by the software shall be encrypted.
15. All system software updates must be available for automatic download and installation via the internet.

B. Historical Database and Analytics Interface
1. System shall provide a historical database that stores device operational history and calculates energy usage for all intelligent control devices.
2. System shall be capable of reporting lighting system events and performance data back to the historical database for display and analysis.
3. Historical database shall be capable of recording historical data for up to 20,000 networked devices for a period of at least 1 calendar year.
4. An “Energy Scorecard” shall be displayed that shows calculated energy savings in dollars, kWh, or CO2.
5. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc.).
6. Energy savings data shall be calculated for the system as a whole or for individual zones.
7. A time scaled graph showing all relay transitions shall be presented.
8. A time scaled graph showing a zones occupancy time delay shall be presented
9. A time scaled graph showing the total light level shall be presented.
10. User shall be able to customize the baseline run-time hours for a space.
11. User shall be able to customize up to four time-of-day billing rates and schedules.
12. Historical data shall be exportable from the Historical Database via a “CSV” type of file format.

C. Visualization and Programming Interfaces
1. System shall provide a web-based visualization interface that displays graphical floorplan.
2. Graphical floorplan shall offer the following types of system visualization:
    a. Full Device Option - A master graphic of the entire building, by floor, showing each control device installed in the project with zones outlined. This shall include, but not be limited to, the following:
        1) Controls devices not embedded in light fixtures
        2) Daylight Sensors
        3) Occupancy Sensors
        4) Wall Switches and Dimmers
        5) Scene Controllers
        6) Networked Relays
        7) Bridges
        8) System Controllers

9) Panels
10) Zone outlines

b. Zone Only Option - A master graphic of the entire building, by floor, showing only control zones outlined.
c. Allow for pan and zoom commands so smaller areas can be displayed on a larger scale simply by panning and zooming each floor's master graphic.
d. A mouse click on any control device shall display the following information (as applicable):
1) The device catalog number.
2) The device name and custom label.
3) Device diagnostic information.
4) Information about the device status or current configuration is available with an additional mouse click.

D. Personal Control Applications
1. Software interface shall support personal control software applications that provide user-specific control of individual luminaires/control devices, control zones, global scene presets, and scene selector virtual button presses.
2. The system administrator shall be capable of defining personal control permissions for each user account.
3. Software interface shall provide a Microsoft Windows® operating system taskbar application for personal lighting control.
4. Software interface shall provide an Apple iOS ® operating system application (supported by mobile phones and mobile tablet devices) for personal lighting control.

E. Smartphone Programming Interface for Wired Devices
1. Application interface shall be provided for both Apple iOS® and Android operating systems that allows configuration of lighting control settings.
2. The application shall support the configuration and control of wired networked control devices via a Bluetooth® Low Energy (BLE) Programming Device.
a. Application shall support a security pin-code to access the zone of lighting control devices.
b. The application shall provide indication of signal strength where multiple Bluetooth Low Energy Programming Devices are available for configuration.
c. The application shall indicate the number of wired networked control devices connected to the local daisy-chain zone.
d. The application shall provide on/off/dimming control of all control groups.
e. The application shall provide the ability to identify all individual luminaires and control devices.
3. Programming capabilities through the application shall include, but not be limited to, the following:
a. Switch/occupancy/photosensor group configuration
b. Manual/automatic on modes
c. Turn-on dim level
d. Occupancy sensor time delays
e. Dual technology occupancy sensors sensitivity
f. Photosensor calibration adjustment and auto-set point
g. Trim level settings
h. Preset scene creation and copy for scene capable devices.
i. Application of a custom device label.

2.05 System Backbone and System Integration Equipment

A. System Controller
1. System Controller shall be multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. System Controller shall have 32-bit microprocessor operating at a minimum of 1 GHz.
3. System Controller shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases.
4. System Controller shall perform the following functions:
   a. Time-based control of downstream wired network devices.
   b. Facilitation of global network switch communication between different system controllers.
   c. Linking into an Ethernet network.
   d. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
   e. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
5. System Controller shall have an integral web server to support configuration, diagnostics and hosting of software interfaces.
6. Device shall have graphical touch screen to support configuration and diagnostics.
7. Device shall have three RJ-45 networked lighting control ports for connection to any of the following:
   a. The graphical touch screen
   b. Wired communication bridges
   c. Direct connection to networked wired luminaires and intelligent lighting control devices (up to 128 total devices per port)
8. Device shall automatically detect all networked devices connected to it, including those connected to wired communication bridges.
9. Device shall have a standard and astronomical internal time clock.
10. Device shall have 2 switched RJ-45 10/100 BaseT Ethernet ports for local area network (LAN) connection.
    a. Ethernet connection shall support IPv4 and shall be capable of using a dedicated static or DHCP assigned IP address.
11. Device shall have 2 x USB 2.0 Expansion ports for 802.11 Wi-Fi Adapter enabling wireless connectivity including:
    a. Hot Spot
    b. Access Point
    c. Client
12. Each System Controller shall be capable of managing and operating at least 750 networked devices.
    a. Multiple System Controllers may be networked together via LAN connection to scale the system up to 20,000 networked devices.
13. System Controller shall support BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
    a. BACnet MS/TP shall support 9600 to 115200 baud rate.
    b. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
14. System controller shall contain a “FIPS 140-2 Level 1 Inside” cryptographic module.

15. System controller shall be available within a NEMA 1 enclosure with Class 1 and Class 2 separation
    a. Enclosure shall support power input power of 120-277VAC, or optional 347VAC

2.06 Wired Networked Devices

A. Wired Networked Wall Switches, Dimmers, Scene Controllers
1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
5. Devices with mechanical push-buttons shall be made available with custom button labeling.
6. Wall switches & dimmers shall support the following device options:
    a. Number of control zones: 1, 2 or 4
    b. Control Types Supported:
        1) On/Off
        2) On/Off/Dimming
    c. Colors: Ivory, White, Light Almond, Gray, Black, Red
7. Scene controllers shall support the following device options:
    a. Number of scenes: 1 to 6.
    b. Control Types Supported:
        1) On/Off
        2) On/Off/Dimming
        3) Preset Level Scene Type
        4) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
        5) Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
    c. Colors: Ivory, White, Light Almond, Gray, Black, Red

B. Wired Networked Graphic Wall Stations
1. Device shall surface mount to single-gang switch box.
2. Device shall have a 3.5" full color touch screen.
3. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
4. Device shall have a micro-USB style connector for local computer connectivity.
5. Communication shall be over standard low voltage network cabling with RJ-45 connectors.
6. Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.
7. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.

8. Graphic wall stations shall support the following device options:
    a. Number of control zones: Up to 16
    b. Number of scenes: Up to 16
    c. Profile type scene duration: User configurable from 5 minutes to 12 hours
    d. Colors: Ivory, White, Light Almond, Gray, Black

C. Wired Networked Digital Key Switches
1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices shall have LED user feedback to provide indication of on/off status of the programmed lights or scene, as well as indication of device power.
5. Digital key switches shall support the following device options:
    a. Control Types Supported:
        1) On/Off
        2) On/Off/Dimming
        3) Preset Level Scene Type
        4) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
        5) Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
    b. Colors: Ivory, White, Light Almond, Stainless Steel

D. Wired Networked Auxiliary Input / Output (I/O) Devices
1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:
    a. Contact closure or Pull High input
        1) Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.
    b. 0-10V analog input
        1) Input shall be programmable to function as a daylight sensor.
    c. RS-232/RS-485 digital input
        1) Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
    d. 0-10V dimming control output, capable of sinking up to 20mA of current
        1) Output shall be programmable to support all standard sequence of operations supported by system.

E. Wired Networked Occupancy and Photosensors
   1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
   2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
   3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.
   4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
   5. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
   6. System shall have ceiling, fixture, recessed & corner mounted sensors available, with multiple lens options available customized for specific applications.
   7. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
   8. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
   9. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
   10. Ceiling mount occupancy sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
   11. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.
   12. Sensors shall have optional features for photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.
   13. Photosensor shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
   14. Photosensor and dimming sensor's set-point and dead band shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
   15. Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
   16. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an "offset" from the primary zone.

F. Wired Networked Wall Switch Sensors
   1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
   2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.

3. All wall switch sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices with mechanical push-buttons shall provide tactile user feedback.
5. Wall switches sensors shall support the following device options:
    a. User Input Control Types Supported: On/Off or On/Off/Dimming
    b. Occupancy Sensing Technology: PIR only or Dual Tech acoustic
    c. Daylight Sensing Option: Inhibit Photosensor
    d. Colors: Ivory, White, Light Almond, Gray

G. Wired Networked Power Packs and Secondary Packs
1. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
2. Power Packs shall accept 120 or 277 VAC and carry a plenum rating.
3. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power.
4. Power Supplies shall provide system power only, but are not required to switch line voltage circuit.
5. Auxiliary Relay Packs shall switch low voltage circuits only, capable of switching 1 amp at 40 VAC/VDC (resistive only).
6. Communication shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors. Secondary packs shall receive low voltage power via standard low voltage network cable.
7. Power Pack programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
8. Power Pack shall securely mount through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
9. When required install Power Pack inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
10. Power/Secondary Packs shall be available with the following options:
    a. Power Pack capable of full 16-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
    b. Secondary Pack with UL924 listing for switching of full 16-Amp Emergency Power circuits, with optional 0-10V dimming output capable of up to 100mA of sink current.
    c. Power and Secondary Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
    d. Secondary Pack capable of full 16-Amp switching of all normal power lighting load types.
    e. Secondary Pack capable of 5-Amps switching and dimming 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
    f. Secondary Pack capable of 5-Amps switching and dimming of 120/277 VAC magnetic low voltage transformers.
    g. Secondary Pack capable of 4-Amps switching and dimming of 120 VAC electronic low voltage transformers.
    h. Secondary Pack capable of louver/damper motor control for skylights.
    i. Secondary Pack capable of providing a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

j. Secondary Pack capable of switching 1 amp at 40 VAC/VDC (resistive only) with the intent to provide relay signal to auxiliary system (e.g. BMS).
k. Power Supply capable of providing auxiliary bus power (no switched or dimmed load).

H. Wired Networked Bluetooth® Low Energy Programming Device
1. Device shall be plenum rated and be inline wired, screw mountable.
2. Communication and low voltage power shall be delivered to device via standard low voltage network cabling with RJ-45 connectors.
3. Bluetooth Low Energy connection shall allow connection from smartphone application for programming device settings within the local daisy-chain zone (*see list of available settings in section 2.4-System Software Interfaces, Sub-section E).*
a. Device shall provide visual indication of remote Bluetooth connection via LED integrated into device enclosure such that it is visible from all angles while the zone is being programmed.

I. Wired Networked Communication Bridge
1. Device shall surface mount to a standard 4” x 4” square junction box.
2. Device shall have 8 RJ-45 ports for connection to lighting control zones (up to 127 devices per port), additional network bridges, and System Controller.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to System Controller.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply, or powered via low voltage network connections from powered lighting control devices (e.g. power packs).
5. Wired Bridge shall be capable of redistributing power from its local supply and connected lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.07 Wireless Networked Devices

A. Wireless Networked Auxiliary Fixture Control Devices
1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Power shall be delivered to each device via standard low voltage wiring from LED driver.

B. Wireless Networked Indoor Occupancy and Photosensors
1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
3. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
4. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.

5. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
6. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
7. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential issue.
8. Power shall be delivered to each device via standard low voltage wiring from a local power pack or by line voltage for devices with available nipple mount.
9. Sensor programming parameter shall be available and configurable remotely from the software
10. Network system shall have ceiling and fixture mounted sensors available, with multiple lens options available customized for specific applications.
11. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
12. Sensors shall have standard daylight photosensor for programmable daylight harvesting
13. Photosensor shall provide foot-candle setpoint and a deadband to prevent the artificial light from cycling. Set-point and deadband shall be capable of automatically calibrating through an “Automatic Set-Point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
14. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
15. Nipple mounted devices shall include option for power interruption detection, where unit powers and controls the emergency circuit, and an interruption of power to this circuit for >30 ms forces unit to shunt closed, go to full bright, and ignore all system commands for 90 minutes

C. Wireless Networked Outdoor Occupancy and Photosensors
1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Sensor shall be available in both nipple mount and in-fixture mount options
   a. Nipple mount sensor shall carry IP66 rating
   b. In-fixture mount sensor shall carry IP65 rating
3. Sensor shall be capable of operating in -40 to 65C ambient temperature ranges
4. Sensors shall be capable of accepting 120-277, 347, or 480VAC input or DC power for embedded device.
5. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
6. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
7. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential issue.
8. Sensor programming parameter shall be available and configurable remotely from the software

9. Nipple mounted sensors shall be available with multiple lens options available for various mounting heights
10. Sensors shall have standard daylight photosensor for programmable daylight harvesting
11. Photosensor shall provide foot-candle setpoint and a deadband to prevent the artificial light from cycling. Set-point and deadband shall be capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
12. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., changes in car type and color, lamp outages).
13. Devices shall include option for power interruption detection, where unit powers and controls the emergency circuit, and an interruption of power to this circuit for >30 ms forces unit to shunt closed, go to full bright, and ignore all system commands for 90 minutes.

D. Wireless Networked Indoor Embedded Sensors
1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Network system shall have embedded sensors consisting of occupancy sensors and/or dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
3. Occupancy sensor detection pattern shall be suitable for 7.5' to 40' mounting heights.
4. Embedded sensors shall support the following configuration options:
   a. Occupancy Sensing technology: PIR only or Dual Tech acoustic
   b. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor
5. Devices shall be available with options for both integrated and remote capable antennas such that devices can be optionally installed in a sealed container without detriment to wireless strength.

E. Wireless Networked Power Packs
1. Communication shall be provided by wireless BLE connection and 900MHz link to other devices.
2. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output
3. Power Packs shall accept 120 through 277 VAC and carry a plenum rating.
4. Power Packs shall be available with optional 24VDC, 100mA output for use with ceiling mount sensors or other DC powered products.
5. Power Packs shall be available with options for integrated and remote capable antennas such that devices can be optionally installed in a sealed container without detriment to wireless strength.
6. Power Pack programming parameters shall be available and configurable remotely from the software
7. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
8. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

9. Power Packs shall be available with the following options:
    a. Power Pack capable of full 20-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
    b. Power Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
    c. Power Packs with UL924 listing capable of full 20-Amp switching of all emergency power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current. There shall be two methods of achieving the UL924 operation:
        1) Power sense of normal power feed, where unit powers and controls emergency circuit, and loss of the normal power sense circuit forces the power pack to shunt closed, go to full bright, and ignore all system commands until normal power is restored.
        2) Power interruption detection, where unit powers and controls the emergency circuit, and an interruption of power to this circuit for >30 ms forces unit to shunt closed, go to full bright, and ignore all system commands for 90 minutes.
    d. Power Packs shall have the option of mounting inside a sealed metal enclosure, with a plenum rated antenna protruding from said enclosure to allow for an IP 67 rated application.

F. Wireless Networked Communication Adapter
1. A communication adapter shall be provided that interfaces with the System Controller via USB connection and interfaces with wireless networked devices via 900MHz.
2. Device shall be capable of communicating with at least 750 wireless networked devices and luminaires
3. Device shall be supplied with mounting hardware suitable for vertical ceiling mounting or for vertical mounting from a wall.
4. Device shall be unresponsive to wired and wireless communications that do not conform to the specific protocols used by the networked lighting control system.
5. Device shall be IP66 rated and shall be optionally installed in an indoor or outdoor location.
6. Device shall allow programming and control of indoor, outdoor, and industrial wireless control devices through a single user interface.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Receive, inspect, handle, and store panels and equipment according to NECA 407.

D. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

E. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install cabling in areas with exposed ceilings in raceways; these areas will be painted.

F. Install equipment in areas with exposed ceiling in enclosures; these areas will be painted.

3.03 PANEL INSTALLATION

A. Comply with NECA 1.

B. Install panels and accessories according to NECA 407.

C. Mount top of trim 72 inches above finished floor unless otherwise indicated.

D. Mount panel cabinet plumb and rigid without distortion of box.

E. Install filler plates in unused spaces.

F. Install barriers as required to provide separation between normal and emergency circuits.

G. Connect unit to the Ethernet network.

H. Install and set up any software and programming required for the unit to be connected to the Ethernet network. The software and programming shall be set up to allow the owner to set up and control the schedules and programming for all the relay panels. The software and programming shall utilize a web browser.

3.04 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

D. Install sensors and devices per the manufacturer’s recommendations.

E. Install sensors and devices per the manufactures sensor drawing layout to achieve guaranteed coverage and operation.

3.05 INSTALLATION

A. Submit a proposed schedule and control sequence to the owner and the engineer for review and comment.

B. Provide a schedule and program the system to meet the ASHRAE 90.1 2010 requirements.

C. Install any required software on the owner's workstation. Set up and provide all required programming for a functional system.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.07 VERIFICATION

A. Review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.

B. Install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.

C. The successful bidder shall be responsible for testing of all low voltage network cable included in the bid. Bidder is responsible for verification of the following minimum parameters:
   1. Wire Map (continuity, pin termination, shorts and open connections, etc.)
   2. Length
   3. Insertion Loss

D. Coordination with Owner's IT Network Infrastructure
   1. Coordinate with the owner's representative to secure all required network connections to the owner's IT network infrastructure.
      a. The bidder shall provide to the owner's representative all network infrastructure requirements of the networked lighting control system.
      b. The bidder shall provide to the manufacturer's representative all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.

E. Documentation and Deliverables
   1. The contractor shall be responsible for documenting installed location of all networked devices. This includes responsibility to provide as-built plan drawing showing device address barcodes corresponding to locations of installed equipment.

2. The contractor is also responsible for the following additional documentation to the manufacturer's representative if visualization / graphical floorplan software is provided as part of bid package:
    a. As-Built floor plan drawings showing daisy-chain wired network control zones outlined, in addition to device address locations required above. All documentation shall remain legible when reproducing\scanning drawing files for electronic submission.
    b. As-Built electrical lighting drawings (reflected ceiling plan) in PDF and CAD format. Architectural floor plans shall be based on as-built conditions.
        1) CAD files shall have layers already turned on/off as desired to be shown in the graphical floorplan background images. The following CAD elements are recommended to be hidden to produce an ideal background graphical image: Titleblock Text- Inclusive of room names and numbers, fixture tags and drawings notes Fixture wiring and homeruns Control devices Hatching or poché of light fixtures or architectural elements.
        2) CAD files shall be of AutoCAD 2013 or earlier. Revit file overall floor plan views shall be exported to AutoCAD 2013.

## 3.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
    1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
    2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

## 3.09 STARTUP SERVICE

A. Perform startup service.
    1. Provide manufacturer's system startup, commissioning, and adjustments.
    2. Complete installation and startup checks according to manufacturer's written instructions.
    3. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.
    4. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed by an authorized representative of the manufacturer.
        a. Low voltage network cable testing shall be performed prior to system startup.
    5. System start-up and programming shall include:
        a. Verifying operational communication to all system devices.
        b. Programming the network devices into functional control zones to meet the required sequence of operation.
        c. Programming and verifying all sequence of operations.
        d. Customization of owner's software interfaces and applications.
    6. Initial start-up and programming is to occur on-site. Additional programming may occur on-site or remotely over the Internet as necessary.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
   2. For daylighting controls, adjust set points and deadband controls to suit Owners operations.

3.11 SYSTEM OPERATING SOFTWARE

A. Contractor shall furnish and install all media which will contain:
   1. Software and current licenses.
   2. All source code pertaining to the System.
   3. All compiled programs pertaining to the System.
   4. All graphics files pertaining to the System.

3.12 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

3.14 COMMISSIONING

A. Summary
   1. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the interior lighting, exterior lighting, lighting control systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Contract Documents. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The commissioning authority will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

B. Lighting and daylighting control systems and equipment included in the commissioning process
   1. Interior lighting.
   2. Exterior lighting.

3. Lighting controls system – interior and exterior.
4. Daylighting controls equipment and software.
5. Sensor for occupancy and daylight levels.
6. Emergency egress lighting – interior and exterior.
7. Light level measurements for selected occupied, worst-case scenario spaces.

C. Master findings list
1. Complete Pre-Functional Testing.
2. All findings from these inspections shall documented.
3. Correct finding(s) and provide written confirmation that the finding(s) have/has been corrected.
4. Once all findings have been resolved and the job is completed, a Final Report will be generated and a final commissioning meeting will be held.

D. Pre-functional testing / manufacturer's checklists
1. The installing contractor will complete the Pre-Functional Testing for each piece of equipment prior to start-up.
2. The equipment manufacturers' checklists must be completed by the installing contractor.

E. Start-up
1. Provide start-up of lighting / daylighting systems.

F. Functional testing
1. Perform functional testing. These tests will be completed for lighting and lighting control systems.
2. Each major system will be tested. A random sample of each subsystem will be tested.

G. Building turn-over / owner orientation / user training
1. Owner training will be provided by the installing contractor or manufacturer's representative.

END OF SECTION 26 0943

# SECTION 26 2213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

## 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 distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
   2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
   3. Include diagrams for power, signal, and control wiring.

### 1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control reports.

C. Field quality-control reports.

### 1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

### 1.06 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
   1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Electric Corporation.
2. Eaton.
3. General Electric Company.
4. Siemens Industry, Inc., Energy Management Division.
5. Sola/Hevi-Duty; a brand of Emerson Electric Co.
6. Square D; by Schneider Electric.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

### 2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.
1. 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.

C. Transformers Rated 15 kVA and Larger:
1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

### 2.03 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
1. One leg per phase.
2. Grounded to enclosure.

C. Coils: Continuous windings without splices except for taps.
1. Coil Material: Aluminum or Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.

D. Enclosure: Ventilated (Indoors).
1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Finish: Comply with NEMA 250.
   a. Finish Color: Gray weather-resistant enamel.

E. Enclosure: Ventilated (Outdoors).
1. NEMA 250, Type 3R: Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
2. Wiring Compartment: Sized for conduit entry and wiring installation.
3. Finish: Comply with NEMA 250.
   a. Finish Color: Gray weather-resistant enamel.

F. Taps for Transformers 3 kVA and Smaller: None.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

K. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

L. Wall Brackets: Manufacturer's standard brackets.

## 2.04 IDENTIFICATION

A. Nameplates (Outdoors): Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

B. Nameplates (Indoors): Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

## 2.05 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

# PART 3 - EXECUTION

## 3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
   1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.03 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. 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.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection.
      a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 2213

# SECTION 26 2413 - SWITCHBOARDS

## 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. Service and distribution switchboards rated 600 V and less.
   2. Disconnecting and overcurrent protective devices.
   3. Instrumentation.
   4. Control power.
   5. Accessory components and features.
   6. Identification.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
   1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
   8. Include schematic and wiring diagrams for power, signal, and control wiring.

### 1.04 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Routine maintenance requirements for switchboards and all installed components.
      b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.07 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

1.08 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.09 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company.
   3. Siemens Industry, Inc., Energy Management Division.
   4. Square D; by Schneider Electric.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

I. Nominal System Voltage: 480Y/277 V.

J. Main-Bus Continuous: 800 A.

K. Indoor Enclosures: Steel, NEMA 250, Type 1.

L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

M. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

N. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
   2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity,.
   3. Copper feeder circuit-breaker line connections.
   4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   5. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.

6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
7. Disconnect Links:
   a. Isolate neutral bus from incoming neutral conductors.
   b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
8. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

## 2.02 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long and short time adjustments.
4. MCCB Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

## 2.03 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:
1. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
   a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
   d. Megawatts: Plus or minus 1 percent.
   e. Megavars: Plus or minus 1 percent.
   f. Power Factor: Plus or minus 1 percent.
   g. Frequency: Plus or minus 0.1 percent.

h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

## 2.04 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

# PART 3 - EXECUTION

## 3.01 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.02 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Install filler plates in unused spaces of panel-mounted sections.

E. Install overcurrent protective devices, surge protection devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Comply with NECA 1.

3.03 CONNECTIONS

A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

B. Support and secure conductors within the switchboard according to NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying 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. Acceptance Testing:
      a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
      b. Test continuity of each circuit.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   3. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   4. Perform the following infrared scan tests and inspections, and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.07 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 26 2413

# SECTION 26 2416 - PANELBOARDS

## 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. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Fused branch circuit panelboards for emergency lighting systems.

### 1.03 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

### 1.04 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.
   1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
   2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details.
   2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
   3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
   4. Detail bus configuration, current, and voltage ratings.
   5. Short-circuit current rating of panelboards and overcurrent protective devices.
   6. Include evidence of NRTL listing for series rating of installed devices.
   7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   8. Include wiring diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.09 FIELD CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than two weeks in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
   1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
   2. Height: 84 inches maximum.
   3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
   4. Finishes:
      a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Galvanized steel.

F. Incoming Mains:
   1. Location: Convertible between top and bottom.

G. Phase, Neutral, and Ground Buses:
   1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
      a. Plating shall run entire length of bus.
      b. Bus shall be fully rated the entire length.
   2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
   3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Tin-plated aluminum.
   2. Terminations shall allow use of 75 deg C rated conductors without derating.
   3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
   4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
   5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
   6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices as noted.

K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
   1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
   2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

## 2.02 POWER PANELBOARDS (DP)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company; GE Energy Management - Electrical Distribution.
   3. Siemens Industry, Inc., Energy Management Division.
   4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker or Lugs only per drawings.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

## 2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS (RP and LP)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company; GE Energy Management - Electrical Distribution.
   3. Siemens Industry, Inc., Energy Management Division.
   4. Square D; by Schneider Electric.
   5. Mersen USA.
   6. Bussman

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

## 2.04 EMERGENCY LIGHTING AND EMERGENCY APPLIANCE BRANCH-CIRCUIT PANELBOARDS (ELP)

A. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper Bussman QSCP or comparable product by the following:
   1. Mersen USA.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Fused disconnect utilizing Low-Peak LP J-SP Class J fuses. Disconnect 70 ampere and larger shall be equipped with operable rotary handle with locking provisions.

D. Branch Overcurrent Protective Devices: Single and multi-pole fused rejection branch disconnects, replaceable without disturbing adjacent units. Cooper Bussman CCPB with indication fuses. Branch circuit fuses shall be low-Peak Class J Cooper Bussman CUBE Fuse

E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

F. Spare Fuses: Provide 25 percent and a minimum of three (3) spare fuses of each type and size.

## 2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company; GE Energy Management - Electrical Distribution.
   3. Siemens Industry, Inc., Energy Management Division.
   4. Square D; by Schneider Electric.

B. MCCB: Comply with UL 489, with series-connected rating to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers:
      a. Inverse time-current element for low-level overloads.
      b. Instantaneous magnetic trip element for short circuits.
      c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
   4. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
   5. Subfeed Circuit Breakers: Vertically mounted.
   6. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Breaker handle indicates tripped status.
      c. UL listed for reverse connection without restrictive line or load ratings.

d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Multipole units enclosed in a single housing with a single handle.
h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.06 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:
   1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Mount top of trim 90 inches (max 72” to top breaker handle) above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box.

I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

J. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
   2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

L. Install filler plates in unused spaces.

M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Do not perform optional tests. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.06 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 2416

# SECTION 26 2726 - WIRING DEVICES

## 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. Standard-grade receptacles, 125 V, 20 A.
2. USB receptacles.
3. GFCI receptacles, 125 V, 20 A.
4. SPD receptacles, 125 V, 20 A.
5. Twist-locking receptacles.
6. Pendant cord-connector devices.
7. Cord and plug sets.
8. Toggle switches, 120/277 V, 20 A.
9. Wall plates.

### 1.03 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

G. SPD: Surge protective device.

### 1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

### 1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.01 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Wiring Devices shall be commercial grade, heavy duty.

C. Comply with NFPA 70.

D. RoHS compliant.

E. Comply with NEMA WD 1.

F. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with requirements in this Section.

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

H. Device Color:
   1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
   2. SPD Devices: Blue.

I. Wall Plate Color: For plastic covers, match device color.

J. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Two pole, three wire, and self-grounding.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Standards: Comply with UL 498 and FS W-C-596.

B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Standards: Comply with UL 498.
   5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

## 2.03 USB RECEPTACLES

A. USB Charging Receptacles:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
   3. USB Receptacles: Dual, USB Type A and C, 5 V dc, and 2.1 A per receptacle (minimum).
   4. Standards: Comply with UL 1310 and USB 3.0 devices.

## 2.04 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Type: Feed through.
   5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

## 2.05 SPD RECEPTACLES, 125 V, 20 A

A. Duplex SPD Receptacles, 125 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
3. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
4. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
5. Configuration: NEMA WD 6, Configuration 5-20R.
6. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

## 2.06 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Receptacles
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).
2. Configuration: NEMA WD 6, Configuration per drawings.
3. Standards: Comply with UL 498.

## 2.07 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton (Arrow Hart).
2. Hubbell Premise Wiring.
3. Leviton Manufacturing Co., Inc.
4. Pass & Seymour/Legrand (Pass & Seymour).

C. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.

D. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

E. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

F. Standards: Comply with FS W-C-596.

## 2.08 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.09 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Comply with UL 20 and FS W-S-896.

D. Four-Way Switches, 120/277 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Standards: Comply with UL 20 and FS W-S-896.

E. Key-Operated, Single-Pole Switches, 120/277 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Factory-supplied key in lieu of switch handle.
   3. Standards: Comply with UL 20 and FS W-S-896.

2.10 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
   3. Material for Unfinished Spaces: Galvanized steel.

4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.

## 3.02 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

## 3.03 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Clear tape with black lettering on face of plate, and durable wire markers or tags inside outlet boxes.

## 3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 2726

# SECTION 26 2813 - FUSES

## 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. Cartridge fuses rated 600 V ac and less for use in the following:
      a. Enclosed controllers.
      b. Enclosed switches.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles. Include the following for each fuse type indicated:
   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   2. Current-limitation curves for fuses with current-limiting characteristics.

### 1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," Section 017823 "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
   4. Coordination charts and tables and related data.

### 1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bussmann, an Eaton business.
   2. Edison; a brand of Bussmann by Eaton.
   3. Littelfuse, Inc.
   4. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

### 2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
   1. Type RK-1: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, time delay.
   3. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, time delay.
   4. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   5. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Feeders: Class RK1, time delay or Class J, time delay.
   2. Motor Branch Circuits: Class RK1, time delay.
   3. Other Branch Circuits: Class RK1, time delay Class J, time delay.
   4. Control Transformer Circuits: Class CC, time delay, control transformer duty.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 2813

# SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

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

### 1.02 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Enclosures.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include wiring diagrams for power, signal, and control wiring.

### 1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
      b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF format.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.07 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.02 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric.
   3. Siemens.
   4. Square D.

B. Type HD, Heavy Duty:
   1. Single throw.
   2. Three pole.
   3. 240 or 600-V ac.
   4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified or indicated fuses.

5. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

## 2.03 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. General Electric Company.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

## 2.04 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12) a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.02 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.

3.03 INSTALLATION

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

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

3.04 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections for Switches:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, grounding, and clearances.
      c. Verify that the unit is clean.
      d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
      e. Verify that fuse sizes and types match the Specifications and Drawings.
      f. Verify that each fuse has adequate mechanical support and contact integrity.
      g. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.
   1. Test procedures used.
   2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
   3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 2816

# SECTION 26 2913.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

## 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. Manual motor controllers.
2. Enclosed full-voltage magnetic motor controllers.
3. Combination full-voltage magnetic motor controllers.
4. Enclosures.
5. Accessories.
6. Identification.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of magnetic controller.
1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

### 1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Routine maintenance requirements for magnetic controllers and installed components.
b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
c. Manufacturer's written instructions for setting field-adjustable overload relays.
d. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

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 use.

B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.

C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.02 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton.
      b. General Electric.
      c. Siemens.
      d. Square D.
   2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
   3. Configuration: Nonreversing.
   4. Flush or Surface mounting.

B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton.
      b. General Electric.
      c. Siemens.
      d. Square D.
   2. Configuration: Nonreversing.
   3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
   4. Overload Relays: NEMA ICS 2, bimetallic class.
   5. Pilot Light: Red.

C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton.
      b. General Electric.
      c. Siemens.
      d. Square D.
   2. Configuration: Nonreversing.
   3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
   4. Overload Relays: NEMA ICS 2, bimetallic class.

## 2.03 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton.
   b. General Electric.
   c. Siemens.
   d. Square D.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Nonreversing.

E. Contactor Coils: Pressure-encapsulated type.
   1. Operating Voltage: Manufacturer's standard, unless indicated.

F. Control Power:
   1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      a. Spare CPT Capacity as Indicated on Drawings: 50 VA.

G. Overload Relays:
1. Solid-State Overload Relay:
a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.
c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
d. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.04 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. General Electric.
3. Siemens.
4. Square D.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Nonreversing.

E. Contactor Coils: Pressure-encapsulated type.
1. Operating Voltage: Manufacturer's standard, unless indicated.

F. Control Power:
1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
a. Spare CPT Capacity as Indicated on Drawings: 50 VA.

G. Overload Relays:
1. Solid-State Overload Relay:
a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.
c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

H. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

I. Fusible Disconnecting Means:
1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

J. Nonfusible Disconnecting Means:
   1. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
   2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.05 ENCLOSURES

A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.

B. The construction of the enclosures shall comply with NEMA ICS 6.

2.06 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
      a. Push Buttons: Covered type.
      b. Pilot Lights: LED type.
      c. Selector switches: Rotary type.

B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.
   1. Phase-failure.
   2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
   3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

2.07 IDENTIFICATION

A. Controller Nameplates: Machine printed, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.02 INSTALLATION

A. Comply with NECA 1.

B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

D. 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.

E. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

## 3.03 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
   2. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with drawings and specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, and grounding.
      d. Verify the unit is clean.
      e. Inspect contactors:
         1) Verify mechanical operation.
         2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
      f. Motor-Running Protection:
         1) Verify overload element rating is correct for its application.
         2) If motor-running protection is provided by fuses, verify correct fuse rating.
      g. Inspect bolted electrical connections for high resistance using one of the two following methods:
         1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
      h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
   3. Electrical Tests:
      a. Perform operational tests by initiating control devices.

C. Motor controller will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 2913.03

# SECTION 26 3213.13 - DIESEL-ENGINE-DRIVEN GENERATOR SETS

## 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. Diesel engine.
2. Diesel fuel-oil system.
3. Control and monitoring.
4. Generator overcurrent and fault protection.
5. Generator, exciter, and voltage regulator.
6. Outdoor engine generator enclosure.
7. Vibration isolation devices.

B. Related Requirements:
1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

### 1.03 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

### 1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:
   1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Identify fluid drain ports and clearance requirements for proper fluid drain.
   4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
   6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.08 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cummins Power Generation.
   2. Generac Power Systems, Inc.
   3. Kohler Power Systems.

B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. B11 Compliance: Comply with B11.19.

B. NFPA Compliance:
1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.

C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier 3 requirements and applicable state and local government requirements.

E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: 5 to 104 deg F.
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 3000 feet.

2.03 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Power Rating: Standby.

D. EPSS Class: Engine generator shall be classified as a Class 24 according to NFPA 110.

E. Power Factor: 0.8, lagging.

F. Frequency: 60 Hz.

G. Voltage: 480-V ac.

H. Phase: Three-phase, four wire, wye.

I. Minimum Starting KVA: 540KVA

J. Induction Method: Naturally aspirated or Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

M. Capacities and Characteristics:
1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

N. Engine Generator Performance:
1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time:
   a. Comply with NFPA 110, Type 10 system requirements.

## 2.04 DIESEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.
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 shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame 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. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve 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-, UV-, and abrasion-resistant fabric.
    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer:
1. Semicritical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
    a. Minimum sound attenuation of 18 dB at 500 Hz.
    b. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

G. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 24-V electric, with negative ground.
1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a 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 to 140 deg F 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. Meters shall 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.

## 2.05 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:
1. State (Oregon) Code Fuel tank meeting all the requirements of the State of Oregon Fire Marshall standards/code. Provide 5 gallon fill/spill containment and normal vent will be extended to 12’ above grade level.
2. Tank level indicator.
3. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for planned operation plus fuel for periodic maintenance operations between fuel refills.
4. Leak detection in interstitial space.
5. Vandal-resistant fill cap.
6. Containment Provisions: Comply with requirements of authorities having jurisdiction.
7. Electrical installer to provide all State of Oregon fuel tank testing and permits and arrange for field testing done by the State Fire Marshall representative or local Fire Department having jurisdiction.

## 2.06 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration:
   1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

F. Control and Monitoring Panel:
   1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
   2. Instruments: Located on the control and monitoring panel and viewable during operation.
      a. Engine lubricating-oil pressure gage.
      b. Engine-coolant temperature gage.
      c. DC voltmeter (alternator battery charging).
      d. Running-time meter.
      e. AC voltmeter, for each phase.
      f. AC ammeter, for each phase.
      g. AC frequency meter.
      h. Generator-voltage adjusting rheostat.
   3. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:
      a. Cranking control equipment.
      b. Run-Off-Auto switch.
      c. Control switch not in automatic position alarm.
      d. Overcrank alarm.
      e. Overcrank shutdown device.
      f. Low-water temperature alarm.
      g. High engine temperature prealarm.
      h. High engine temperature.
      i. High engine temperature shutdown device.
      j. Overspeed alarm.
      k. Overspeed shutdown device.
      l. Low fuel main tank.
         1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required for the indicated EPSS class.
      m. Coolant low-level alarm.
      n. Coolant low-level shutdown device.
      o. Coolant high-temperature prealarm.
      p. Coolant high-temperature alarm.
      q. Coolant low-temperature alarm.
      r. Coolant high-temperature shutdown device.
      s. EPS load indicator.
      t. Battery high-voltage alarm.
      u. Low cranking voltage alarm.
      v. Battery-charger malfunction alarm.
      w. Battery low-voltage alarm.

x. Contacts for local and remote common alarm.
y. Remote manual stop shutdown device.
z. Generator overcurrent-protective-device not-closed alarm.
aa. Hours of operation.
bb. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

G. Connection to Datalink:
1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via Ethernet. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

H. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

I. Common Remote Annunciator Panel: The remote annunciator shall meet NFPA 110, Level 1 requirements and enable remote viewing of the generator status. The panel shall be connected to the generator controller via either network communication wires or via hard wired connections. The panel shall provide ATS source availability, contactor position, and loaded or unloaded test for up to four transfer switches. The panel shall have the capability to be either flush- mounted or surface-mounted. The annunciator shall meet UL508 requirements. Remote panel shall be powered from the engine-generator set battery.

J. 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 unless otherwise indicated.

K. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

## 2.07 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.
1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:
1. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:
a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

## 2.08 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12-lead alternator.

E. Range: Provide extended range of output voltage by adjusting the excitation level.

F. 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.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
   1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
   2. Maintain voltage within 30 percent on one step, full load.
   3. Provide anti-hunt provision to stabilize voltage.
   4. Maintain frequency within 10 percent and stabilize at rated frequency within 2 seconds.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

## 2.09 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description:
   1. Vandal-resistant, sound-attenuating, weatherproof steel housing; wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph.

C. Hinged Doors: With padlocking provisions.

D. Muffler Location: Within enclosure.

E. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
   1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.

F. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

## 2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of

sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene separated by steel shims.
2. Shore A Scale Durometer Rating: 50.
3. Number of Layers: Two.
4. Minimum Deflection: 1 inch.

B. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   1. Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:
   1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
   3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure enclosure to anchor bolts installed in concrete bases.

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.03 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

3.04 IDENTIFICATION

A. Identify system components according to Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.
      a. Visual and Mechanical Inspection:
         1) Compare equipment nameplate data with Drawings and the Specifications.
         2) Inspect physical and mechanical condition.
         3) Inspect anchorage, alignment, and grounding.
         4) Verify that the unit is clean.
      b. Electrical and Mechanical Tests:
         1) Perform insulation-resistance tests according to IEEE 43.
            a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
         2) Test protective relay devices.
         3) Verify phase rotation, phasing, and synchronized operation as required by the application.
         4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
         5) Perform vibration test for each main bearing cap.
         6) Verify correct functioning of the governor and regulator.
   2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
   3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      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 all connectors. Perform an integrity load test and a capacity load test for the battery.
      c. Verify acceptance of charge for each element of the battery after discharge.
      d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. 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.

B. Coordinate tests with tests for transfer switches and run them concurrently.

C. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

D. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Remove and replace malfunctioning units and retest as specified above.

H. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

## 3.06 MAINTENANCE SERVICE

A. Initial Maintenance Service/Agreement: Beginning at Substantial Completion, provide two (2) visits during the first year (semi-annual) of full recommended maintenance by skilled employees of manufacturer's designated service organization. Include exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Perform load bank test during 2nd visit. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

## 3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 3213.13

# SECTION 26 3600 - TRANSFER SWITCHES

## 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. Contactor-type automatic transfer switches.
   2. Nonautomatic transfer switches.
   3. Transfer switch accessories.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
   2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
   2. Include material lists for each switch specified.
   3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
   4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

### 1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

### 1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Features and operating sequences, both automatic and manual.
      b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.06 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

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 NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. 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, unless otherwise indicated.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   1. Short-time withstand capability for three cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Neutral Terminal: Solid and fully rated unless otherwise indicated.

K. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
   4. Accessible via front access.

M. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.02 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cummins Power Generation.
   2. Generac Power Systems, Inc.
   3. Kohler Power Systems.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
   4. Conductor Connectors: Suitable for use with conductor material and sizes.
   5. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
   6. Main and Neutral Lugs: Mechanical type.
   7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   8. Ground bar.
   9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Open and Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
   1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
   2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
   3. Fully automatic break-before-make operation with center off position.
   4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.

E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

G. Automatic Transfer-Switch Controller Features:
   1. Controller operates through a period of loss of control power.
   2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:
    a. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a 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 shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

H. Large-Motor-Load Power Transfer:
1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.03 MANUAL TRANSFER SWITCHES (MTS)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ESL Power Systems, Inc; StormSwitch Manual Transfer Switch
   2. PSI Power and Controls
   3. ASCO: a brand of Vertiv.
   4. Eaton.

B. Manual Operated: Manual transfer switch shall consist of (2) two mechanically-interlocked molded case circuit breakers, cam-style male connectors, power distribution block and grounding terminals, all housed within a pad lockable enclosure.

C. Enclosure: Manual transfer switch enclosure shall be Type 3R, constructed of continuous seam-welded, powder coated galvanneal steel. The main access shall be through an interlocked, hinged door that extends the full height of the enclosure. Access for portable generator cables with female cam-style plugs shall be via a) drawn flange cable entry openings in the bottom of enclosure for wall mount units, or b) hinged lower door for pad mount units. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened. Enclosure shall be powder coated after fabrication.

D. Temporary Connections: Cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Cam-style male connectors shall be provided for each phase and for ground, and shall also be provided for neutral if required. Each of the phase cam-style male connectors within the enclosure shall be factory-wired to a molded case circuit breaker. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor. The neutral cam-style male connectors, if required, shall be factory wired to a power distribution block. None of the cam-style male connectors shall be accessible unless both molded case circuit breakers are in the “OFF” position and the main access door is open.

E. Permanent Connections: A power distribution block shall be provided for line-side field wiring. The power distribution block shall be factory wired to the molded case circuit breakers.

F. Molded Case circuit breakers shall be UL Listed and the short circuit interrupt rating shall be a minimum of 35kAIC at 480VAC minimum. Trip rating of the molded case circuit breakers shall be as shown on the drawings. One molded case circuit breaker shall be fed from utility power; the other molded case circuit breaker shall be fed from the cam-style male connectors to supply power from a portable generator. Both molded case circuit breakers shall include UL Listed door-mounted operating mechanisms, preventing the opening of the main access door unless both breakers are in the “OFF” position. Both molded case circuit breakers shall be mounted behind a deadfront panel. The load-side of the molded case circuit breakers shall not be energizable unless the main access door is closed and one of the molded case circuit breakers is in the “ON” position. The (2) molded case circuit breakers shall be safety interlocked by mechanical means to ensure that only one breaker can be closed at any given time

G. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac for remote annunciation to indicate that permanent emergency source is disconnected from the emergency system.

H. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Switch Action: Double throw; mechanically held in both directions.

2. Contacts: Silver composition or silver alloy for load-current switching.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Mechanical type.
6. Ground Lugs and Bus-Configured Terminators: Mechanical type.
7. Ground bar.
8. Connectors shall be marked for conductor size and type according to UL 1008.

## 2.04 TRANSFER SWITCH ACCESSORIES

A. Remote Annunciator System:
   1. Source Limitations: Same manufacturer as transfer switch in which installed.
   2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
   3. Annunciation panel display shall include the following indicators:
      a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
      b. Switch position.
      c. Switch in test mode.
      d. Failure of communication link.
   4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
      a. Indicating Lights: Grouped for each transfer switch monitored.
      b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
      c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
      d. Lamp Test: Push-to-test or lamp-test switch on front panel.

B. Remote Annunciator and Control System:
   1. Each transfer switch shall be connected to common generator remote annunciator.

## 2.05 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. 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.

B. Prepare test and inspection reports.
   1. For each of the tests required by UL 1008, performed on representative devices, for emergency systems. Include results of test for the following conditions:
      a. Overvoltage.
      b. Undervoltage.
      c. Loss of supply voltage.
      d. Reduction of supply voltage.
      e. Alternative supply voltage or frequency is at minimum acceptable values.
      f. Temperature rise.
      g. Dielectric voltage-withstand; before and after short-circuit test.
      h. Overload.
      i. Contact opening.
      j. Endurance.
      k. Short circuit.
      l. Short-time current capability.
      m. Receptacle withstand capability.
      n. Insulating base and supports damage.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

B. Identify components according to Section 260553 "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Comply with NECA 1.

3.02 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets,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.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

H. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

I. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

J. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.03 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:
   1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. After installing equipment, test for compliance with requirements according to NETA ATS.
   2. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with Drawings and Specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and required clearances.
      d. Verify that the unit is clean.
      e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
      f. Verify that manual transfer warnings are attached and visible.
      g. Verify tightness of all control connections.
      h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
      i. Perform manual transfer operation.
      j. Verify positive mechanical interlocking between normal and alternate sources.
      k. Perform visual and mechanical inspection of surge arresters.
      l. Inspect control power transformers.
         1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
         2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
         3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
   3. Electrical Tests:
      a. Perform insulation-resistance tests on all control wiring with respect to ground.
      b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
      c. Verify settings and operation of control devices.
      d. Calibrate and set all relays and timers.
      e. Verify phase rotation, phasing, and synchronized operation.
      f. Perform automatic transfer tests.
      g. Verify correct operation and timing of the following functions:
         1) Normal source voltage-sensing and frequency-sensing relays.
         2) Engine start sequence.
         3) Time delay on transfer.
         4) Alternative source voltage-sensing and frequency-sensing relays.
         5) Automatic transfer operation.
         6) Interlocks and limit switch function.
         7) Time delay and retransfer on normal power restoration.
         8) Engine cool-down and shutdown feature.
   4. 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.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and retransfer from 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.
    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 3600

# SECTION 26 4313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Type 2 surge protective devices.
   2. Enclosures.
   3. Conductors and cables.

B. Related Requirements:
   1. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
   2. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
   3. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

### 1.02 DEFINITIONS

A. $I_n$: Nominal discharge current.

B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.

C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.

D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).

E. SCCR: Short-circuit current rating.

F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

H. Type 3 SPDs: Point of utilization SPDs.

I. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.

J. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.

K. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

### 1.03 ACTION SUBMITTALS

A. Product Data:
   1. For each type of product.
      a. Include electrical characteristics, specialties, and accessories for SPDs.

b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:
   1) Tested values for VPRs.
   2) $I_n$ ratings.
   3) MCOV, type designations.
   4) OCPD requirements.
   5) Manufacturer's model number.
   6) System voltage.
   7) Modes of protection.

B. Field quality-control reports.

1.04 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.05 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.
   1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.

PART 2 - PRODUCTS

2.01 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB, Electrification Products Division.
   2. Advanced Protection Technologies Inc. (APT).
   3. Eaton.
   4. Leviton Manufacturing Co., Inc.
   5. Schneider Electric USA, Inc.
   6. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. General Characteristics (Typical all types):
   1. Reference Standards: UL 1449, Type 2; UL 1283.
   2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
   3. SCCR: Equal or exceed 100 kA.
   4. $I_n$ Rating: 20 kA.

D. Options:
   1. Include LED indicator lights for power and protection status.
   2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
   4. Include surge counter (Service Entrance only).

2.02 SERVICE ENTRANCE SUPPRESSOR – TYPE A

A. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

B. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

2.03 DISTRIBUTION PANEL SUPPRESSORS – TYPE B

A. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

B. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Neutral to Ground: 1200 V for 480Y/277 V.
4. Line to Line: 2000 V for 480Y/277 V

C. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 700 V for 208Y/120 V.
3. Neutral to Ground: 700 V for 208Y/120 V.
4. Line to Line: 1200 V for 208Y/120 V

2.04 PANELBOARD SUPPRESSORS – TYPE C

A. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

B. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Neutral to Ground: 1200 V for 480Y/277 V.
4. Line to Line: 2000 V for 480Y/277 V

C. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 700 V for 208Y/120 V.
3. Neutral to Ground: 700 V for 208Y/120 V.
4. Line to Line: 1200 V for 208Y/120 V

2.05 ENCLOSURES

A. Indoor Enclosures: Type 1.

2.06 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
   2. Do not exceed manufacturer's recommended lead length.
   3. Do not bond neutral and ground.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.02 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
   2. Inspect anchorage, alignment, grounding, and clearances.
   3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

B. Nonconforming Work:
   1. SPDs that do not pass tests and inspections will be considered defective.
   2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

3.03 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 26 4313

# SECTION 26 5119 - LED INTERIOR LIGHTING

## 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 LED luminaires.

B. Related Requirements:
   1. Section 260943 "Lighting Control System" for manual and programmable control system with low voltage control wiring and data communication circuits.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   6. Photometric data and adjustment factors based on laboratory tests[, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project; IES LM-79 and IES LM-80.
      a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
      b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

### 1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

### 1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Drivers: One for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.07 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.09 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

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. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

C. Recessed luminaires shall comply with NEMA LE 4.

2.02 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Steel:
   1. ASTM A 36/A 36M for carbon structural steel.
   2. ASTM A 568/A 568M for sheet steel.

C. Stainless Steel:
   1. Manufacturer's standard grade.
   2. Manufacturer's standard type, ASTM A 240/240 M.

D. Galvanized Steel: ASTM A 653/A 653M.

E. Aluminum: ASTM B 209.

2.03 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.04 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, 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 luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Flush-Mounted Luminaires:
1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

E. Wall-Mounted Luminaires:
1. Attached to structural members in walls.
2. Attached to a minimum 20 gauge backing plate attached to wall structural members.
3. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaires:
1. Ceiling Mount:
a. Two 5/32-inch diameter aircraft cable supports adjustable to 10 feet in length.
b. Pendant mount with 5/32-inch diameter aircraft cable supports adjustable to 10 feet in length.
2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod wire support for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling-Grid-Mounted Luminaires:
1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

H. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

## 3.03 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 5119

# SECTION 26 5213 - EMERGENCY AND EXIT LIGHTING

## 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. Emergency lighting.
   2. Exit signs.
   3. Luminaire supports.

### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
   1. Include data on features, accessories, and finishes.
   2. Include physical description of the unit and dimensions.
   3. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
   4. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
      a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
      b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Product Schedule:
   1. For emergency lighting units. Use same designations indicated on Drawings.
   2. For exit signs. Use same designations indicated on Drawings.

### 1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

### 1.05 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

### 1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.07 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

2.02 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Lighting Unit:
   1. Emergency Lighting Unit: As indicated on Luminaire Schedule.
   2. Wall with universal junction box adaptor.
   3. UV stable thermoplastic housing.
   4. Internal emergency power unit.

2.03 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Operating at nominal voltage of 120 V ac or 277 V ac.
   2. Lamps for AC Operation:
      a. LEDs; 50,000 hours minimum rated lamp life.

2.04 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:
   1. Smooth operating, free of light leakage under operating conditions.
   2. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally.

C. Diffusers and Globes:
   1. Glass: Annealed crystal glass unless otherwise indicated.
   2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.05 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. 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.

2.06 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:
1. Sized and rated for luminaire and emergency power unit weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

D. Wall-Mounted Luminaire Support:
1. Attached to structural members in walls.
2. Attached to a minimum 20-gage backing plate attached to wall structural members.
3. Attached using through bolts and backing plates on either side of wall.
4. Do not attach luminaires directly to gypsum board.

E. Suspended Luminaire Support:
1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Ceiling Grid Mounted Luminaires:
1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

## 3.03 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to generator power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 5213

# SECTION 26 5613 - LIGHTING POLES AND STANDARDS

## 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. Poles and accessories for support of luminaires.

### 1.03 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete luminaire.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

### 1.04 ACTION SUBMITTALS

A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.
   1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
   2. Include finishes for lighting poles and luminaire-supporting devices.
   3. Anchor bolts.
   4. Manufactured pole foundations.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly of poles and pole accessories.
   4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
   5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
   6. Method and procedure of pole installation. Include manufacturer's written installations.

### 1.05 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

B. Field quality-control reports.

C. Sample Warranty: Manufacturer's standard warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Pole repair materials.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B660.

B. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.09 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.
   2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
   3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-6-M.

B. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.
   1. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph.
      a. Wind Importance Factor: 1.0.
      b. Minimum Design Life: 25 years.

c. Velocity Conversion Factor: 1.0.

E. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

F. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

## 2.02 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B221, Alloy 6063-T6, with access handhole in pole wall.
1. Shape: Round, tapered.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Grounding and Bonding Lugs: Bolted 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

C. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

D. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

## 2.03 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

B. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept indicated accessories. Include removable flanged access cover secured with bolts or screws.

## 2.04 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F1554, Grade 55, with a minimum yield strength of 55,000 psi.
1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
2. Rod length and dimension as recommended by manufacture for pole and base assembly
3. Threading: Uniform National Coarse, Class 2A.

B. Nuts: ASTM A563, Grade A, Heavy-Hex.
   1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
   2. Two nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.

C. Washers: ASTM F436, Type 1.
   1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
   2. Two washer(s) provided per anchor bolt.

2.05 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage 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 poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Anchor Bolts: Install plumb using manufacturer-supplied steel template, uniformly spaced.

3.03 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
   1. Fire Hydrants and Water Piping: 60 inches.
   2. Water, Gas, Electric, Communications, and Sewer Lines: 60 inches

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

## 3.04 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

## 3.05 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

## 3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION 26 5613

# SECTION 26 5619 - LED EXTERIOR LIGHTING

## 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. Luminaire types.
   2. Materials.
   3. Finishes.
   4. Luminaire support components.

B. Related Requirements:
   1. Section 260943 "Lighting Control System" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

### 1.03 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 1.04 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaire.
   4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   5. Photometric data and adjustment factors based on laboratory tests.
      a. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   6. Wiring diagrams for power, control, and signal wiring.
   7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of the following:
   1. Luminaire.

C. Source quality-control reports.

D. Sample warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.

1.07 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:
   1. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.09 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including luminaire support components.
      b. Faulty operation of luminaires and accessories.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. CRI of minimum 80. CCT of 4000 K.

F. L70 lamp life of 50,000 hours.

G. Internal driver.

H. Nominal Operating Voltage: 120 V ac and 277 V ac.

I. Lamp Rating: Lamp marked for outdoor use.

J. Source Limitations:
1. Obtain luminaires from single source from a single manufacturer.
2. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.02 LUMINAIRE TYPES

A. Refer to Luminaire Schedule on the drawings.

2.03 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:
1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

G. Housings:
   1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
   2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage and coating.
      c. CCT and CRI for all luminaires.

2.04 FINISHES

A. Variations in Finishes: 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.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
   4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

2.05 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, 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 luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Install lamps in each luminaire.

C. Fasten luminaire to structural support.

D. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Support luminaires without causing deflection of finished surface.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wiring Method: Install cables in raceways. Conceal raceways and cables.

F. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

G. Coordinate layout and installation of luminaires with other construction.

H. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.04 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.05 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.07 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Verify operation of photoelectric controls.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 5619

# SECTION 27 0526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

## 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. Grounding conductors.
   2. Grounding connectors.
   3. Grounding busbars.
   4. Grounding labeling.

### 1.03 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

### 1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.05 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
   1. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Field quality-control reports.

### 1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
      a. Result of the ground-resistance test, measured at the point of BCT connection.
      b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

PART 2 - PRODUCTS

2.01 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

2.02 CONDUCTORS

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green insulation, insulated for 600 V, and complying with UL 83.
   1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
   2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

C. Cable Tray Grounding Jumper:
   1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

D. Bare Copper Conductors:
   1. Stranded Conductors: ASTM B 8.
   2. Bonding Conductor: No. 2 or No. 6 AWG, stranded conductor.
   3. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Burndy; Part of Hubbell Electrical Systems.
   2. Chatsworth Products, Inc.
   3. Harger Lightning & Grounding.
   4. Panduit Corp.
   5. Tyco Electronics Corp.

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
   1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.04 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chatsworth Products, Inc.
   2. Erico
   3. Harger Lightning & Grounding.
   4. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.
   1. Predrilling shall be with holes for use with lugs specified in this Section.
   2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
   3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.
   1. Predrilling shall be with holes for use with lugs specified in this Section.
   2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
   3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.
   1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.

2.05 LABELING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brother International Corporation.
   2. HellermannTyton.
   3. Panduit Corp.

B. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.03 APPLICATION

A. Conductors: Stranded conductors for No. 6 AWG and larger unless otherwise indicated.
   1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 2 AWG.
   2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 2 AWG.

B. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Structural Steel: Welded connectors.

C. Conductor Support:
   1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

D. Grounding and Bonding Conductors:
   1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
   2. Install without splices.
   3. Support at not more than 36-inch intervals.
   4. Install grounding and bonding conductors in backbone cable tray or 3/4-inch conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT.
      a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 0528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.04 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.05 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

3.06 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
   1. Use crimping tool and the die specific to the connector.
   2. Pretwist the conductor.
   3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install rack grounding busbar unless the enclosure and rack are manufactured with the busbar or other bonding connection provision. Bond the equipment grounding busbar to the TGB with No. 6 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

3.07 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.
   1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
   2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
   3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
      a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
   3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
      a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Engineer promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 27 0526

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

## 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. 19-inch equipment racks.
   2. Power strips.
   3. Backboards
   4. Grounding.
   5. Labeling.

B. Related Requirements:
   1. Section 27 0526 "Grounding and Bonding for Telecommunications Equipment" for TMGBs and TGBs.
   2. Section 27 1313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
   3. Section 27 1323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
   4. Section 27 1513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
   5. Section 27 1523 "Communications Optical Fiber Horizontal Cabling" for optical-fiber data cabling associated with system panels and devices.

### 1.03 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
   2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.01 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 06 1000 "Rough Carpentry."

2.02 19-INCH EQUIPMENT RACKS

A. Description: Two- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CommScope, Inc.
   2. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
   3. Ortronics, Inc.
   4. Panduit Corp.

C. General Requirements:
   1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
   2. Material: Extruded aluminum.
   3. Finish: Manufacturer's standard, baked-polyester powder coat.
   4. Color: Black.

D. Floor-Mounted Racks:
   1. Overall Height: 84 inches.
   2. Upright Depth: 3 inches
   3. Two-Post Load Rating: 200 lb.
   4. Number of Rack Units per Rack: 42.
   5. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
   6. Base shall have a minimum of four mounting holes for permanent attachment to floor.

7. Top shall have provisions for attaching to cable tray or ceiling.
8. Self-leveling.

E. Cable Management:
1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

## 2.03 POWER STRIPS

A. Power Strips: Comply with UL 1363.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. 13 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Cord connected with 15-foot line cord.
8. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
9. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

## 2.04 GROUNDING

A. Comply with requirements in Section 27 0526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.
1. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

## 2.05 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

# PART 3 - EXECUTION

## 3.01 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
   1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
   4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

## 3.02 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.
   1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

## 3.03 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 27 0553 "Identification for Electrical Systems."

B. Comply with requirements in Section 09 9123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 4 level of administration, including optional identification requirements of this standard.

D. Labels shall be machine printed. Type shall be 1/8 inch in height.

END OF SECTION 27 1116

# SECTION 27 1313 - COMMUNICATIONS COPPER BACKBONE CABLING

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Backbone communications cables.

### 1.02 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

### 1.03 ACTION SUBMITTALS

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

### 1.04 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted-pair cable for open and short circuits.

## PART 2 - PRODUCTS

### 2.01 BACKBONE COMMUNICATIONS CABLES

A. Description: This category covers multiple conductor jacketed communications cable for telephone and other communications circuits for use in risers and plenums as described in Article 800 of NFPA 70.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. UL DUZX and DVBI - Type CMR, Category 5e Communications Cable:
   1. Product Marking: Type CMR; Category 5e.
   2. Options:
      a. Quantity of Pairs: 25.
      b. Shielding/Screening: UTP.
      c. Jacket: Gray thermoplastic.

PART 3 - EXECUTION

3.01 INSTALLATION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation:
   1. Communications Cable Assemblies: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N1.
   2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:
   1. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
      a. Provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
      b. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.
   2. Drawings indicate general arrangement of pathways and fittings.
   3. Wiring Methods:
      a. Raceway and Tray: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
      b. Open-Cable: Route conductors and cables in accessible ceilings, walls, and floors where possible.
      c. Within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.
   4. General Requirements for Cabling:
      a. Install 110-style IDC termination hardware unless otherwise indicated.
      b. Do not untwist twisted-pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
      c. Terminate all conductors; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
      d. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
      e. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
      f. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars and distribution spools.
      g. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
      h. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
      i. In the communications equipment room, install 10 ft long service loop on each end of cable.
      j. Pulling Cable: Monitor cable pull tensions.

5. Open-Cable Installation:
   a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   b. Suspend twisted-pair cabling, not in a wireway or pathway, a minimum of 8 inch above ceilings by cable supports not more than 5 ft apart.
   c. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
6. Group connecting hardware for cables into separate logical fields.
7. Identify system components, wiring, and cabling in accordance with TIA-606.
   a. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
8. Cable and Wire Identification:
   a. Label each cable within 4 inch of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
   b. Each wire connected to building-mounted devices is not required to be numbered at device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
   d. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from panel or cabinet to building-mounted device, with name and number of particular device.
      2) Label each unit and field within distribution racks and frames.
   e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

## 3.02 FIELD QUALITY CONTROL OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Tests and Inspections:
   1. Perform manufacturer's recommended tests and inspections.
   2. Visually inspect jacket materials for certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
   3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   4. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
      a. Test instruments must meet or exceed applicable requirements in TIA-568.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Nonconforming Work:
   1. Cable assemblies will be considered defective if it does not pass tests and inspections.
   2. Remove and replace defective cable assemblies and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.03 PROTECTION

A. After installation, protect cable assemblies and accessories from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 27 1313

# SECTION 27 1323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Optical fiber backbone cable.
   2. Optical fiber cable hardware.

### 1.02 DEFINITIONS

A. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

B. Types OFN and OFNG: Nonconductive cable for general purpose use.

### 1.03 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

### 1.04 ACTION SUBMITTALS

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

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine continuity of strand end to end. Use optical fiber flashlight or optical loss test set.
   2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

## PART 2 - PRODUCTS

### 2.01 TYPES OFN AND OFNG OPTICAL FIBER CABLE

A. Types OFN and OFNG Optical Fiber Cable: This category covers jacketed optical fiber cable for general use within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN QAYK; including UL 1651.

3. General Characteristics:
    a. Performance: TIA-568.3.
    b. Inside Plant Mechanical Properties: ICEA S-83-596.
    c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
    d. Jacket:
        1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
        2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Types OFN and OFNG, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Berk-Tek, a Leviton Company.
    b. CommScope, Inc.
    c. Mohawk; a division of Belden Networking, Inc.
    d. Superior Essex Inc.; subsidiary of LS Corp.
    e. General Cable
2. Source Limitations: Obtain products from single manufacturer.
3. Additional Characteristics:
    a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
4. Options:
    a. Configuration:
        1) 12-fiber, single loose tube, optical fiber cable.
    b. Maximum Attenuation: 0.4 dB/km at 1310 nm wavelength; 0.3 dB/km at 1550 nm wavelength.
    c. Jacket Color: Black.
    d. Dry Water Block cable core.

## 2.02 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berk-Tek, a Leviton Company.
2. CommScope, Inc.
3. Corning Optical Communications; Corning Incorporated.
4. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
5. Siemon Co. (The).
6. Panduit Corp.

B. Performance Criteria:
1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, dual-fiber cables in 36 inch lengths.

E. Connector Type: Type LC complying with TIA-604-10, connectors.

F. Plugs and Plug Assemblies:
   1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
   2. Insertion loss not more than 0.25 dB.

G. Jacks and Jack Assemblies:
   1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
   2. Insertion loss not more than 0.25 dB.
   3. Designed to snap-in to patch panel or faceplate.

## 2.03 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections:
   1. Test and inspect optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

B. Nonconforming Work:
   1. Cables that do not pass tests and inspections will be considered defective.

C. Prepare test and inspection reports.

# PART 3 - EXECUTION

## 3.01 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:
   1. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   2. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:
   1. Comply with TIA-568.1 and TIA-568.3.
   2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
   3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
   9. In communications equipment room, provide 10 ft long service loop on each end of cable.
   10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
   11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Group connecting hardware for cables into separate logical fields.

3.02 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606.

B. Cable and Wire Identification:
   1. Label each cable within 4 inch of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
   4. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

C. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:
   1. Flexible vinyl or polyester that flexes as cables are bent.

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Optical Fiber Cable Tests:
      a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      b. Link End-to-End Attenuation Tests:
         1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.
         2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

B. Nonconforming Work:
   1. Cables will be considered defective if they do not pass tests and inspections.
   2. Remove and replace defective cables and retest.

C. Collect, assemble, and submit test and inspection reports.
   1. Data for each measurement must be documented.
   2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

END OF SECTION 27 1323

# SECTION 27 1513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Category 6 twisted pair cable.
   2. Twisted pair cable hardware.
   3. Identification products.

B. Related Requirements:
   1. Section 27 1116 "Communications Racks, Frames, and Enclosures".

### 1.02 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.03 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between MDF/IDF and the equipment outlet, otherwise known as horizontal cabling in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
   2. Bridged taps and splices shall not be installed in the horizontal cabling.

B. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Field Quality-Control Submittals:
   1. Field quality-control reports.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, installation supervisor, and field inspector.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.09 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.02 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
   1. Communications, Plenum Rated:
      a. Type CMP complying with UL 1685.
      b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.03 CATEGORY 6 TWISTED PAIR CABLE

A. Category 6 Twisted Pair Cable: Four-pair, balanced -twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Premise Wiring
   2. Leviton
   3. Panduit Corp.
   4. SYSTIMAX Solutions, a CommScope Inc. brand.

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Plenum.

G. Jacket: Refer to schedule on drawings for color, thermoplastic.

2.04 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Premise Wiring
   2. Leviton
   3. Panduit Corp.
   4. SYSTIMAX Solutions, a CommScope Inc. brand.

C. General Requirements for Twisted Pair Cable Hardware:
   1. Comply with the performance requirements of Category 6.
   2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
   3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

E. Connecting Blocks:
   1. 110-style IDC for Category 6.
   2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
   3. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
   1. Features:
      a. Universal T568A and T568B wiring labels.
      b. Labeling areas adjacent to conductors.
      c. Replaceable connectors.
      d. 24 or 48 ports.
   2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
   3. Number of Jacks per Field: One for each four-pair cable indicated.

G. Patch Cords: Factory-made, four-pair cables in lengths required; terminated with an eight-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
   2. Patch cords shall have color-coded boots for circuit identification.

H. Plugs and Plug Assemblies:
   1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Standard: Comply with TIA-568-C.2.

I. Jacks and Jack Assemblies:
   1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Designed to snap-in to a patch panel or cover plate.
   3. Standard: Comply with TIA-568-C.2.

J. Faceplate:

1. One, Two, Three and four port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Eight port, vertical double gang faceplates designed to mount to double gang wall boxes.
3. Metal Faceplate: Stainless steel complying with requirements in Section 26 2726 "Wiring Devices."
4. For use with snap-in jacks accommodating any combination of twisted pair, AV and coaxial work area cords.

K. Legend:
1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.05 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.06 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WIRING METHODS

A. Routing:
1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces. Cables in the Transfer Station area shall be in raceway.
a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."
2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.02 INSTALLATION OF PATHWAYS

A. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."

B. Comply with Section 26 0529 "Hangers and Supports for Electrical Systems."

C. Drawings indicate general arrangement of pathways and fittings.

3.03 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:
   1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
   2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
   3. Install 110-style IDC termination hardware unless otherwise indicated.
   4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
   5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   6. MUTOA shall not be used as a cross-connect point.
   7. Consolidation points may be used only for making a direct connection to equipment outlets:
      a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
      b. Locate consolidation points for twisted pair cables at least 49 feet from communications equipment room.
   8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
   10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
   11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
   12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
   14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:
   1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
   4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
   5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
   6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

## 3.04 FIRESTOPPING

A. Comply with requirements in Section 07 8413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

## 3.05 GROUNDING

A. Comply with requirements in Section 27 0526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.06 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 0553 "Identification for Communications Systems."
   1. Administration Class: Class 4.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 4 level of administration, including optional identification requirements of this standard.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
   4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
      b. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections:

B. Tests and Inspections:
   1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Nonconforming Work:
1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. Collect, assemble, and submit test and inspection reports.

END OF SECTION 27 1513

# SECTION 28 3100 - INTRUSION DETECTION

## 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. Intrusion detection with communication links to perform monitoring, alarm, and control functions.

B. Related Sections:
   1. Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" for power cabling between master control units and field-mounted devices and control units.
   2. Section 27 1513 "Communications Copper Horizontal Cabling" for Category 6 horizontal (general use, riser-, and plenum-rated) cabling.

### 1.03 DEFINITIONS

A. PIR: Passive infrared.

B. RFI: Radio-frequency interference.

C. Control Unit: System component that monitors inputs and controls outputs through various circuits.

D. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

E. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

F. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

G. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

### 1.04 ACTION SUBMITTALS

A. Product Data: Components for sensing, detecting, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
   1. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
   2. Master Control-Unit Console Layout: Show required artwork and device identification.
   3. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
   4. Details of surge-protection devices and their installation.
   5. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
   1. Data for each type of product, including features and operating sequences, both automatic and manual.
   2. Master control-unit hardware and software data.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:
   1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
   2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Description: Hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
   1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
   2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
   3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

D. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

E. Operator Commands:
   1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
   2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
   3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
   4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
   5. Protected Zone Test: Initiate operational test of a specific protected zone.
   6. System Test: Initiate system-wide operational test.

F. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

G. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

H. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

I. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

J. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

## 2.02 SYSTEM COMPONENT REQUIREMENTS

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. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

C. Comply with NFPA 70.

D. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
   1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 4313 "Surge Protection for Low-Voltage Electrical Power Circuits."
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

E. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

F. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

G. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

## 2.03 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

## 2.04 SECURE AND ACCESS DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bosch Security Systems, Inc.
   2. Digital Security Controls Ltd.
   3. Edwards; Carrier Global Corporation.
   4. Honeywell International Inc.

B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

C. Key-Operated Switch: Change protected zone between secure and access conditions.

2.05 DOOR AND WINDOW SWITCHES

A. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

B. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

C. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

2.06 PIR SENSORS

A. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

B. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
   1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet.
   2. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree conical.

C. Device Performance:
   1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
   2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.

2.07 MASTER CONTROL UNIT

A. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
   1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
   2. Include a real-time clock for time annotation of events on the event recorder and printer.

B. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: LCD, three line(s) of 40 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
   3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.

4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
   a. Acknowledge alarm.
   b. Silence alarm.
   c. System reset.
   d. LED test.
6. Timing Unit: Solid state, programmable, 365 days.
7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
8. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone originating the alarm appears on LCD display at master control unit.
9. Alarm activation sounds a siren.

C. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

D. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

E. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify, with permanent labels, individual components and modules within cabinets.

F. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

## 2.08 AUDIBLE AND VISUAL ALARM DEVICES

A. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet from master control unit.
   1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

# PART 3 - EXECUTION

## 3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

D. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

3.03 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Section 26 0533 "Raceways and Boxes for Electrical Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Wires and Cables:
   1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
   2. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

G. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0533 "Identification for Electrical Systems."

3.04 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 26 0553 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from master control unit.

3.05 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 27 0526 "Grounding and Bonding for Communications Systems."

3.06 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
   1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
   1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
   2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

D. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

E. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 28 3100

# SECTION 28 4621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

## 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. Addressable fire-alarm system.
   2. Fire-alarm control unit (FACU).
   3. Manual fire-alarm boxes.
   4. System smoke detectors.
   5. Duct smoke detectors.
   6. Fire-alarm notification appliances.
   7. Fire-alarm remote annunciators.
   8. Fire-alarm addressable interface devices.
   9. Digital alarm communicator transmitters (DACTs).
   10. Fire-alarm radio transmitters.

B. Related Requirements:
   1. Section 08 7100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
   2. Section 26 0523 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.

### 1.03 DEFINITIONS

A. DACT: Digital alarm communicator transmitter.

B. EMT: Electrical metallic tubing.

C. FACU: Fire-alarm control unit.

D. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).

E. NICET: National Institute for Certification in Engineering Technologies.

F. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
   1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
   2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.04 ACTION SUBMITTALS

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.

C. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, and details, including details of attachments to other Work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
   4. Annunciator panel details as required by authorities having jurisdiction.
   5. Detail assembly and support requirements.
   6. Include voltage drop calculations for notification-appliance circuits.
   7. Include battery-size calculations.
   8. Include input/output matrix.
   9. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
   10. Include performance parameters and installation details for each detector.
   11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   12. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.
   13. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
      a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
      b. Show field wiring and equipment required for HVAC unit shutdown on alarm.
      c. Locate detectors in accordance with manufacturer's written instructions.
      d. Show air-sampling detector pipe routing.
   14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.
   1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
   2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
   3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Qualification Statements: For Installer.

C. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
      a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
      b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
      c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
      d. Riser diagram.
      e. Device addresses.
      f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
      g. Record copy of site-specific software.
      h. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
         1) Equipment tested.
         2) Frequency of testing of installed components.
         3) Frequency of inspection of installed components.
         4) Requirements and recommendations related to results of maintenance.
         5) Manufacturer's user training manuals.
      i. Manufacturer's required maintenance related to system warranty requirements.
      j. Abbreviated operating instructions for mounting at FACU and each annunciator unit.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media and approved online or cloud solution.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.07 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
   2. Installation must be by personnel certified by NICET as fire-alarm Level IV technician.
   3. Obtain certification by NRTL in accordance with NFPA 72.
   4. Licensed or certified by authorities having jurisdiction.

1.08 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 ADDRESSABLE FIRE-ALARM SYSTEM

A. Description:
   1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn-and-strobe notification for evacuation.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.
   2. General Characteristics:
      a. Automatic sensitivity control of certain smoke detectors.
      b. Fire-alarm signal initiation must be by one or more of the following devices and systems:
         1) Manual stations.
         2) Heat detectors.
         3) Flame detectors.
         4) Smoke detectors.
         5) Duct smoke detectors.
         6) Automatic sprinkler system water flow.
         7) Preaction system.
         8) Fire-extinguishing system operation.
         9) Fire standpipe system.
         10) Dry system pressure flow switch.
         11) Fire pump running.
      c. Fire-alarm signal must initiate the following actions:
         1) Continuously operate alarm notification appliances.
         2) Identify alarm and specific initiating device at FACU, connected network control panels, off-premises network control panels, and remote annunciators.
         3) Transmit alarm signal to remote alarm receiving station.
         4) Unlock electric door locks in designated egress paths.
         5) Activate voice/alarm communication system.
         6) Activate preaction system.
         7) Activate emergency lighting control.
         8) Record events in system memory.
         9) Indicate device in alarm on graphic annunciator.
      d. Supervisory signal initiation must be by one or more of the following devices and actions:
         1) Valve supervisory switch.
         2) High- or low-air-pressure switch of dry-pipe or preaction sprinkler system.
         3) Independent fire-detection and -suppression systems.

4) Fire pump is running.
5) Fire pump has lost power.
6) Power to fire pump has phase reversal.
7) Zones or individual devices have been disabled.
8) FACU has lost communication with network.

e. System trouble signal initiation must be by one or more of the following devices and actions:
1) Open circuits, shorts, and grounds in designated circuits.
2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4) Loss of primary power at FACU.
5) Ground or single break in internal circuits of FACU.
6) Abnormal ac voltage at FACU.
7) Break in standby battery circuitry.
8) Failure of battery charging.
9) Abnormal position of switch at FACU or annunciator.

f. System Supervisory Signal Actions:
1) Initiate notification appliances.
2) Identify specific device initiating event at FACU, connected network control panels, off-premises network control panels, and remote annunciators.
3) After time delay of 200 seconds, transmit trouble or supervisory signal to remote alarm receiving station.
4) Transmit system status to building management system.

g. Network Communications:
1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.

h. Document Storage Box:
1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
3) Color: Red powder-coat epoxy finish.
4) Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
5) Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.

## 2.02 FIRE-ALARM CONTROL UNIT (FACU)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Edwards; Carrier Global Corporation.
2. Notifier; Honeywell International, Inc.
3. Potter Electric Signal Company, LLC.
4. Silent Knight; Honeywell International, Inc.
5. Simplex; brand of Johnson Controls International plc, Building Solutions North America.

B. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.

C. Performance Criteria:
   1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
   2. General Characteristics:
      a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
      b. Include real-time clock for time annotation of events on event recorder and printer.
      c. Provide communication between FACU and remote circuit interface panels, annunciators, and displays.
      d. FACU must be listed for connection to central-station signaling system service.
      e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACU must provide minimum 500-event history log.
      f. Addressable Initiation Device Circuits: FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
         1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACU must be listed for releasing service.
      g. Fire-Alarm Annunciator: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
         1) Annunciator and Display: LCD, 80 characters, minimum.
         2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
      h. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
         1) Annunciator and Display: LCD, three line(s) of 80 characters, minimum.
         2) Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into system for control of smoke-detector sensitivity and other parameters.
      i. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
         1) Pathway Class Designations: NFPA 72, Class B.
         2) Pathway Survivability: Level 0.
         3) Install no more than 50 addressable devices on each signaling-line circuit.
         4) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.
      j. Serial Interfaces:
         1) One dedicated RS 485 port for central-station operation using point ID DACT.
         2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
         3) One USB port for PC configuration.
      k. Smoke-Alarm Verification:
         1) Initiate audible and visible indication of "alarm-verification" signal at FACU.
         2) Activate approved "alarm-verification" sequence at FACU and detector.

3) Record events by system printer.
4) Sound general alarm if alarm is verified.
5) Cancel FACU indication and system reset if alarm is not verified.

l. Notification-Appliance Circuit:
1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
2) Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
3) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.

m. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.

n. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals supervisory and DACT and digital alarm radio transmitters must be powered by 24 V(dc) source.

o. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.

p. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.

q. Batteries: Sealed lead calcium.

D. Accessories:
1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.

## 2.03 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
2. Station Reset: Key- or wrench-operated switch.
3. Able to perform at up to 90 percent relative humidity at 90 deg F.
4. Material: Manual stations made of Lexan polycarbonate.
5. Able to be used in indoor areas.

## 2.04 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors:
1. Performance Criteria:
a. Regulatory Requirements:
1) NFPA 72.
2) UL 268.

b. General Characteristics:
1) Detectors must be two-wire type.
2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
a) Primary status.
b) Device type.
c) Present average value.
d) Present sensitivity selected.
e) Sensor range (normal, dirty, etc.).
8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
9) Color: White.
10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F per minute.
12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F.
13) Multiple levels of detection sensitivity for each sensor.
14) Sensitivity levels based on time of day.

B. Ionization Smoke Detectors:
1. Performance Criteria:
a. Regulatory Requirements:
1) NFPA 72.
2) UL 268.
b. General Characteristics:
1) Detectors must be two-wire type.
2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.

7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
   a) Primary status.
   b) Device type.
   c) Present average value.
   d) Present sensitivity selected.
   e) Sensor range (normal, dirty, etc.).
8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
9) Color: White.
10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F per minute.
12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F.
13) Multiple levels of detection sensitivity for each sensor.
14) Sensitivity levels based on time of day.

## 2.05 DUCT SMOKE DETECTORS

A. Description: Photoelectric-type, duct-mounted smoke detector.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. NFPA 72.
      b. UL 268A.
   2. General Characteristics:
      a. Detectors must be two-wire type.
      b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
      c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
      d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
      e. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
      f. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
         1) Primary status.
         2) Device type.
         3) Present average value.
         4) Present sensitivity selected.
         5) Sensor range (normal, dirty, etc.).
      g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
      h. Each sensor must have multiple levels of detection sensitivity.
      i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

## 2.06 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Audible Notification Appliances:
1. Description: Horns, bells, or other notification devices that cannot output voice messages.
2. Performance Criteria:
a. Regulatory Requirements:
1) NFPA 72.
b. General Characteristics:
1) Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
2) Sounders, High Volume 24 V(dc): Less than 6 mA of alarm current.
3) Sounders, Low Volume 24 V(dc): Less than 4 mA of alarm current.
4) Audible notification appliances must have functional humidity range of 10 to 95 percent relative humidity.
5) ISO Temporal 3 Evacuation Tone: 90 plus or minus 4 dB(A-weighted) at 24 V.
6) ISO Temporal 3 Alert Tone: 95 plus or minus 5 dB(A-weighted) at 24 V.
7) AS2220 Evacuation Tone: 93 plus or minus 4 dB(A-weighted) at 24 V.
8) AS2220 Alert Tone: 93 plus or minus 5 dB(A-weighted) at 24 V.
9) Horns: Electric-vibrating-polarized type, 24 V(dc); with provision for housing operating mechanism behind grille. Comply with UL 464. Horns must produce sound-pressure level of 90 dB(A-weighted), measured 10 ft. from horn, using coded signal prescribed in UL 464 test protocol.
10) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
11) Color: White (finished ceilings, finished spaces), Red (Transfer Station area)

B. Fire-Alarm Visible Notification Appliances:
1. Performance Criteria:
a. Regulatory Requirements:
1) NFPA 72.
2) UL 1971.
b. General Characteristics:
1) Rated Light Output:
a) 15/30/75/110 cd, selectable in field.
2) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
3) Mounting: Wall or ceiling mounted as indicated.
4) Flashing must be in temporal pattern, synchronized with other units.
5) Strobe Leads: Factory connected to screw terminals.
6) Color: White (finished ceilings, finished spaces), Red (Transfer Station area)

2.07 FIRE-ALARM REMOTE ANNUNCIATORS

A. Performance Criteria:
1. Regulatory Requirements:
a. NFPA 72.
2. General Characteristics:
a. Annunciator functions must match those of FACU for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACU, including acknowledging, silencing, resetting, and testing.
1) Mounting: Flush cabinet, NEMA 250, Type 1.
b. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of FACU. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.08 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Performance Criteria:
1. Regulatory Requirements:
a. NFPA 72.
2. General Characteristics:
a. Include address-setting means on module.
b. Store internal identifying code for control panel use to identify module type.
c. Listed for controlling HVAC fan motor controllers.
d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
e. Integral Relay: Capable of providing direct signal.
1) Allow control panel to switch relay contacts on command.
2) Have minimum of two normally open and two normally closed contacts available for field wiring.
f. Control Module:
1) Operate notification devices.
2) Operate solenoids for use in sprinkler service.

2.09 DIGITAL ALARM COMMUNICATOR TRANSMITTERS (DACTs)

A. Performance Criteria:
1. Regulatory Requirements:
a. NFPA 72.
2. General Characteristics:
a. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
b. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU and automatically capture two telephone line(s) and dial preset number for remote central station. When contact is made with central station(s), signals must be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of telephone line to remote alarm receiving station over remaining line. Transmitter must automatically report telephone service restoration to central station. If service is lost on both telephone lines, transmitter must initiate local trouble signal.

c. Local functions and display at DACT must include the following:
   1) Verification that both telephone lines are available.
   2) Programming device.
   3) LED display.
   4) Manual test report function and manual transmission clear indication.
   5) Communications failure with central station or FACU.
d. Digital data transmission must include the following:
   1) Address of alarm-initiating device.
   2) Address of supervisory signal.
   3) Address of trouble-initiating device.
   4) Loss of ac supply.
   5) Loss of power.
   6) Low battery.
   7) Abnormal test signal.
   8) Communication bus failure.
e. Secondary Power: Integral rechargeable battery and automatic charger.
f. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

## 2.10 FIRE-ALARM RADIO TRANSMITTERS

A. Performance Criteria:
   1. Regulatory Requirements:
      a. NFPA 72.
      b. NFPA 1221.
      c. 47 CFR 90.
   2. General Characteristics:
      a. Must be factory assembled, wired, and tested; ready for installation and operation.
      b. Packaging: Single, modular, NEMA 250, Type 1 metal enclosure with tamper-resistant flush tumbler lock.
      c. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of established remote alarm receiving station designated by Owner.
      d. Normal Power Input: 120 V(ac).
      e. Secondary Power: Integral-sealed, rechargeable, 12 V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
         1) Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports must withstand 100 mph with gust factor of 1.3 without failure.
         2) Antenna Cable: Coaxial cable with impedance matched to transmitter output impedance.
         3) Antenna-Cable Connectors: Weatherproof.
         4) Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to transmitter, matching fire-alarm and other system outputs to message-generating inputs of transmitter that produce required message transmissions.

f. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU or from its own internal sensors or controls and must automatically transmit signal along with unique code that identifies transmitting station to remote alarm receiving station. Transmitted messages must correspond to standard designations for fire-reporting system to which signal is being transmitted and must include separately designated messages in response to the following events or conditions:
   1) Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
   2) System Test Message: Initiated manually by test switch within transmitter cabinet, or automatically at optionally preselected time, once every 24 hours, with transmission time controlled by programmed timing device integral to transmitter controls.
   3) Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of transmitter normal power source, derangement of wiring of transmitter, or alarm input interface circuit or device connected to it.
   4) Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause trouble signal to be indicated on building system.
   5) Local Fire-Alarm-System Alarm Message: Actuated when building system goes into alarm state. Identifies device that initiated alarm.
   6) Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when building alarm system indicates supervisory alarm.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.

B. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

### 3.03 INSTALLATION OF EQUIPMENT

A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
   1. Devices placed in service before other trades have completed cleanup must be replaced.

2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inch above finished floor.

C. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in normal path of egress within 60 inch of exit doorway.
2. Mount manual fire-alarm box on background of contrasting color.
3. Operable part of manual fire-alarm box must be between 42 and 48 inch above floor level. Devices must be mounted at same height unless otherwise indicated.

D. Smoke- and Heat-Detector Spacing:
1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing must not exceed 30 ft..
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inch from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inch from lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch long must be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Air-Sampling Smoke Detectors: If using multiple pipe runs, runs must be pneumatically balanced.

H. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

I. Audible Alarm-Indicating Devices: Install not less than 6 inch below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch below ceiling. Install devices at same height unless otherwise indicated.

K. Device Location-Indicating Lights: Locate in public space near device they monitor.

L. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists wind load of 100 mph with gust factor of 1.3 without damage.

3.04 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 0526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 26 0553 "Identification for Electrical Systems."

3.05 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 26 0523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.06 PATHWAYS

A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inch above floor must be installed in conduit.

B. Pathways in Transfer Station area must be installed in conduit.

C. Exposed conduit must be painted red enamel.

3.07 CONNECTIONS

A. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
   1. Alarm-initiating connection to activate emergency lighting control.
   2. Supervisory connections at valve supervisory switches.
   3. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
   4. Supervisory connections at fire-pump power failure including dead-phase or phase-reversal condition.
   5. Supervisory connections at fire-pump engine control panel.

3.08 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0533 "Identification for Electrical Systems."

B. Install framed instructions in location visible from FACU.

3.09 GROUNDING

A. Ground FACU and associated circuits in accordance with Section 26 0526 "Grounding and Bonding for Electrical Systems."

B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

A. Field tests must be witnessed by authorities having jurisdiction.

B. Administrant for Tests and Inspections:
   1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
      b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
   2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
   3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
   4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
   5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
   6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Allow Owner to record training.

3.12 MAINTENANCE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
   1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
   2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
   3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

END OF SECTION 28 4621.11

# SECTION 313700

# RIPRAP

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section includes description of riprap stone and geotextile fabric placed in stormwater channels and stormwater outlet and letdown locations as shown on the Drawings.

B. Related Sections

1. Section 334200 – Stormwater Drainage Systems

### 1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

### 1.3 SUBMITTALS

A. Submit under provisions of Section 013300.

B. Test Results: The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.

## PART 2 PRODUCTS

### 2.1 RIPRAP

A. The stone shall be hard, sound, and durable. It shall be free from seams, cracks, and other defects tending to destroy its resistance to weather.

B. The stone shall have less than 45 percent wear in accordance with the Los Angeles abrasion test and shall have a unit weight not less than 140 pounds per cubic foot.

C. Unless otherwise specified on plan drawings the stone shall have a $d_{50}$ equal to 8 inches.

D. Dust or fines less than 1/2 inch in maximum cross-section accumulated from quarrying or loading operations shall not exceed five percent by weight.

E. Unless otherwise specified on plan drawings the stone shall be nominal 18 inches graded down.

# PART 3 EXECUTION

## 3.1 GENERAL

A. Riprap shall be installed at all locations shown on the Drawings.

B. Riprap shall be placed to produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids and shall be constructed to the lines and grades shown.

C. The riprap shall be placed to its full course thickness in one operation. The material placement process shall begin at the lower elevations and progress up the slope. The larger stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified. The finished riprap layer shall be free from objectionable pockets of small stones and clusters of larger stones.

D. Placing riprap layers will not be permitted. Placing of riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by: selective loading of the material at the quarry or other source, controlled dumping of successive loads during final placing, or by other methods of placement which will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes as specified above.

E. Riprap lining will not extend vertically above the adjacent finished grade to limit the potential to restriction overland flow outside the ditch from entering the ditch.

F. Riprap shall be maintained in a satisfactory condition, as determined by the CQA ENGINEER, until completion of the project. Damage before completion from any cause shall be repaired or replaced at no cost to the OWNER.

END OF SECTION

## SECTION 320190 – 90-DAY ESTABLISHMENT PERIOD

## PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The General Conditions of the contract apply to the work of this section the same as though written herein.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, and equipment to provide, and install, landscape drainage pipe, drain inlets and grates, tree pit drainage systems, and plant pit breather tubes as described herein and upon the drawings.

B. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damage, injury, and loss due to his acts or neglect. Contractor shall continuously protect and maintain all areas included in the contract during the progress of the work, through the establishment period, and until final acceptance of the work. Contractor is responsible for all repairs or replacements caused by acts of vandalism, including theft.

C. The Contractor shall employ only Certified Landscape Technicians (CLT's) with the Oregon Landscape Contractors Association (OLCA), as foremen for all landscape drainage installation work.

D. Landscape maintenance of designated areas as specified herein. During and at the end of the maintenance period, all plant material shall be in a healthy, growing condition. Contractor shall provide all equipment, labor, all landscaped areas, turf sports fields, turf playfields, lawns, mulched areas, hydroseeded areas, slopes, tree wells, and other landscaped areas constructed as a part of this contract and materials necessary for performing landscape maintenance according to the following specifications.

E. Complete landscape maintenance of entire site, including, but not limited to: pruning, shaping and training of trees, shrubs, and ground cover plants; fertilization; weed control, control of all plant diseases and insect pests; maintenance and repairs of irrigation and drainage systems; rodents; and all other maintenance required to maintain the landscaping in safe, attractive, and usable condition, and maintain all plant materiel in good condition with horticulturally acceptable growth and color.

1.3 RELATED SECTIONS

A. 328400 Landscape Irrigation
B. 329113 Soil Preparation
C. 329300 Plants

1.4 SUBMITTALS

A. Submit descriptive literature and specifications for the following:
B. Any materials, which differ from that, specified, when a brand name is called for on the drawings or in these specifications.
C. Contractor shall submit to the Landscape Architect within 30 days from notice to proceed photocopies of current CLT registration for all foremen performing work on this project.

1.3 QUALITY OF WORK

A. All work shall be performed in accordance with the best landscape maintenance practices and shall be in keeping with the high aesthetic level of the facilities being maintained.

1.4 DEFINITION

A. Where "as directed", "as required", "as permitted", "approved", "acceptance", or words of similar import are used, it shall be understood that the direction, requirement,

permission, approval or acceptance of the Owner is intended unless otherwise stated. As used herein, “provide” shall be understood to mean “ provide complete”, in place, that is “furnish and install”, the word “site” as used hereinafter shall be understood to mean the location receiving the service. The use of the word “Owner” shall be construed to mean Bend Research Inc. or its delegated representative(s). The use of the Word “Contractor” shall be held to mean the Contractor and/or any person employed by him and working under this contract. The use of the words “shall” and “may” shall be held to mean “mandatory” and “permissible”, respectively. The use of the word “pruning” shall include the practices sometimes referred to as “trimming”.

1.5 CONTRACTOR’S RESPONSIBILITIES

A. Local Office: The contractor shall maintain a local office with a competent English-speaking company representative that can be reached during normal working hours and authorized to discuss matters pertaining to this contract with the Owner. A local office is one that can be reached by telephone without it being a toll call. An answering service or mobile telephone shall not fulfill the requirement for a local office.

B. Licenses and Permits: The Contractor shall, prior to award of contract and without additional expense to the Owner, possess all licenses and permits required for the performance of the work required by this Contract.

C. Personnel:
   1. The Contractor shall furnish sufficient supervisory and working personnel capable of promptly accomplishing on schedule, to the satisfaction of the owner, all work required under this contract during the regular and prescribed hours.
   2. The Contractor and his employees shall conduct themselves in a proper and efficient manner at all times and shall cause the least possible annoyance to the students, faculty, and the public. They shall be fully clothed in suitable uniformed attire.
   3. The Contractor shall provide restroom facilities, i.e. (Porta John) at the maintenance yard for employee use.
   4. Lunches are to be taken off-site or at the maintenance yard.
   5. All contractor maintenance vehicles shall be marked with the company name and/or logo so as to identify personnel working on the job.
   6. The Owner may require the Contractor to remove from the work site any employee(s) deemed careless, incompetent, or otherwise objectionable, whose continued employment on the job is considered to be contrary to the best interests of the Owner.
   7. The Contractor shall have competent English-speaking supervisor, who may be a working supervisor, on the job at all times work is being performed, who are capable of discussing with the Owner matters pertaining to this contract. Supervisor must have a minimum of three years of actual field experience in landscape maintenance exclusively and must be able to demonstrate to the satisfaction of the Owner that they possess adequate technical background. Supervisor must possess a current CLT certificate in landscape maintenance. Adequate and competent supervision shall be provided for all work being done by the Contractor’s employees to ensure accomplishment of high-quality work which will be acceptable to the Owner. In addition, a non-working supervisor shall inspect all areas under the contract a minimum of two (2) times each week.

D. Repairs to Existing Facilities
   1. All portions of buildings, structures, equipment or other facilities, including irrigation systems, lighting, and signage which are damaged or altered in any way, as a result of the performance of work under this specification during the terms of the contract, shall be repaired or replaced in kind and in an approved manner. All work of this kind shall be performed by the Contractor at no extra cost to the Owner and shall be

accomplished as directed by the Owner. Repairs to facilities shall be make immediately after damage or alteration occurs, unless otherwise directed. A comprehensive testing and check of all irrigation systems shall be make approximately 30 days before the end of the contract and any repairs deemed the responsibility of the Contractor shall be made by the Contractor to the satisfaction of the Owner.

2. The Contractor shall keep controller and valve boxes clear of soil and debris and maintain the irrigation system including the replacement, repair, adjustment, raise or lower, straighten, and any other operations required for the continued proper operation of the system from the water meter throughout the site. Repair or replacement includes, but is not limited to: sprinkler system laterals (piping), sprinkler mains (pressure lines), mainline sleeves, sprinkler control valves, sprinkler controllers, sprinkler heads, sprinkler caps, sprinkler head riser, valve covers, boxes and lids, including electrical pull boxes and lids, valve sleeves, quick coupler valves, hose bibs, and booster pumps.
3. The Owner shall be notified, within twenty-four (24) hours, of any damage caused by accident, vandalism, theft, acts of God, or mysterious causes and shall follow up notification within four (4) working days with a written description of the problem and steps taken, if any, to rectify the problems.
4. Repairs to existing structures or facilities, including irrigation systems, which are damaged or altered in any way, including acts of God, vandalism, vehicular damage, theft or mysterious damages that do not result from the performance or lack of performance of the work by the Contractor, shall be repaired by the Contractor as directed by the Owner at no cost to the Contractor except where the specifications provide otherwise. Invoices for repairs to existing facilities shall be broken down by phases and units, into parkways, medians, slopes, entry monuments or recreation areas.
5. Any replacement must conform to the type and kind of existing system. Any deviation must be submitted in writing for approval by the Owner prior to installation. Any materials installed without this approval, and subsequently rejected by the Owner, shall be promptly removed by the Contractor at no cost to the Owner.

E. Safety Requirements: All work performed under this contract shall be performed in such a manner as to provide maximum safety to the public and where applicable, comply with all safety standards required by CAL-OSHA. The Owner reserves the right to issue restraint or cease and desist order to the Contractor when unsafe or harmful acts are observed or reported relative to the performance of the work under this contract.

F. Hazardous Conditions: The Contractor shall maintain all work sites free of hazards to persons and or property resulting from his operations. Any hazardous condition noted by the Contractor, which is not a result of this operation, shall be immediately reported to the Owner.

G. Use of Chemicals: The Contractor shall submit a list of all chemicals, herbicides, rodenticides, and pesticides proposed for use under this contract for approval by the Owner. Material included on this list shall be limited to chemicals approved by the State of Oregon, Department of Agriculture, and shall include the exact brand name and generic foundation. The use of any chemicals on the list shall be based on the recommendations of a licensed pest control advisor. The use of chemicals shall conform to the current jurisdictional regulations. The Contractor shall notify the Owner in writing a minimum of four (4) working days prior to the application of any herbicide, rodenticide, or pesticide. Such notices shall include the purpose and area such chemicals are to be used. The Owner shall retain the option to disapprove the application of such chemicals before their application. The monthly report required in paragraph 1.5.2 in the General Conditions of these specifications, shall include a

statement of all applications of herbicides, rodenticides, and pesticides detailing the chemical used, quantity, rate of application, area in which used and the purpose of the application. The uses of these chemicals shall be kept in an 8 1/2" x 11" ring notebook that shall be kept up to date and available for inspection by the Owner at all times.

H. Litter
   1. Contractor-Generated Trash: The Contractor shall promptly remove from the work area all debris generated by his performance of pruning, trimming, weeding, edging and other work required in the specifications. The Contractor shall clean, with suitable equipment, public streets and walks, driveways, and paved areas immediately after working in the areas and at such other times as may be required by the Owner.
   2. Litter Pickup: All areas in the work site shall be kept free of, but not limited to the following items: bottles, glass, cans, paper, cardboard, metallic items, and other debris. Litter pickup (litter removal from slope areas) shall be removed from the site and shall not be placed in "on-site" containers.
   3. Broken glass, a hazard, and other material or litter which may be hazard shall be picked up and removed from the site immediately by the Contractor.
   4. Seating areas, lunch courts, exercise areas, tunnel area, parking areas and other areas may on occasion be exceptionally littered and shall be cleared of litter before noon on the business day after the litter occurs.

I. Failure to Perform Satisfactorily: Those discrepancies and deficiencies in the work that remain uncorrected may be the necessary justification for a billing adjustment in the month following in the occurrence. Billing adjustments for this unsatisfactory service shall be permanent retention of 100% of the estimated monthly cost for work that is incomplete or deficient as stated herein.

J. Emergency Calls: The Contractor shall have the capability to receive and to respond immediately to calls of an emergency nature during normal working hours and during hours outside of normal working hours. Calls of an emergency nature received by the Owner shall be referred to the Contractor for immediate disposition.

K. Monthly Walk-Throughs: The Contractor shall provide to the Owner a schedule of monthly walk- throughs. Any changes to this schedule shall be provided to the Owner at least two weeks prior to that meeting. Monthly maintenance walk-through to be performed with the Contractor and Owner's representative.

1.6 REPORTS / INSPECTIONS

A. No special work shall be performed without first obtaining the written approval of the Owner.

B. As part of the service, the Contractor shall submit a monthly "Landscape Report" to the Owner. This report shall outline the general condition of the landscape areas, any problem areas that have been found, recommendations on how the landscape should be improved and the status of projects pursuant to maintenance programs in progress.

C. Once a month the Contractor shall accompany the Owner's Representative on a landscape inspection to review the status of maintenance, Landscape Report, and the landscape in general.

## PART 2- MATERIALS

2.1 All replacement landscape materials shall be per Section 329300 of these specifications.

2.2 Fertilizer shall be per Section 329113.

2.3 Supplemental fertilizer shall be per Section 32 91 00. N - P - K analysis shall be determined by soils analysis reports, when needed.

2.4 Replacement plant materials shall be per Section 329300.
2.5 Pre-emergent herbicides shall be per Section 329300.
2.6 Touch-up paint for site furnishings such as pots, trash/recycle containers, benches, exercise equipment and the like shall be from the corresponding site furnishings manufacturer/supplier.

## PART 3 - EXECUTION

3.1 Scheduling of Work: The Contractor shall accomplish all normal landscape maintenance required under this contract between the hours of 7:00 a.m. and 8:00 p.m., Monday through Saturday. Exceptions may be made to normal working hours, where incidence of use may be too great during the hours specified to allow for proper maintenance. The Owner may grant, on an individual basis, permission to perform contract maintenance at other hours. No maintenance function that generates excess noise which would cause annoyance to residences in the area shall be commenced before 8:00 a.m... The Contractor shall establish a schedule of routine work to be followed in performance of this contract. This schedule shall include, but not be limited to turf mowing and edging days, dates of weeding, and dates for fertilizer application. This schedule shall be revised quarterly and a copy of this schedule shall be provided to the Owner prior to the performance of any work required by these specifications, and any changes in scheduling shall be reported, in writing, to the Owner immediately.

3.2 WORKFORCE

A. For each area of maintenance responsibility, the contractor shall assign the following minimum work force of competent, experienced maintenance personnel full-time to this project.

| Description | Personnel Assigned |
|---|---|
| General Site Trash Removal, Sweeping, Cleaning | 0.5 |
| Irrigation System Maintenance and Repair | 0.5 |
| Fertilization/Plant Replacements/Pruning | 0.5 |
| Total personnel assigned full-time | 1.5 |

B. This work force shall be the minimum work force assigned to this period on a continuing day-to-day basis. If temporary conditions or emergency situations arise which prevent routine maintenance from being performed, according to the schedules and performance standards of these specifications, the Contractor shall assign additional personnel and crews on a temporary basis as required, to assure performance standards of this contract are continually being met. This includes the need to close off a lane when performing maintenance on parkways with the proper coning and significant notification to the Bend Parks and Recreation District and the City of Bend. This shall be done at no additional cost to the Owner.

C. As additional areas are added to and made part of the contract, the number of personnel assigned will be adjusted as required, to adequately maintain all landscaped areas according to the provisions and performance schedules and standards of these specifications. The Contractor shall conduct the work at all times in a manner which will not interfere with normal pedestrian traffic on adjacent sidewalks or vehicular traffic on adjacent streets. In addition, a special schedule listing exact starting date for pesticide application, fertilization pruning and other infrequent operations, shall be furnished to the Owner on a yearly basis and any changes in scheduling shall be reported in writing, to the Owner immediately.

3.3 METHOD OF PERFORMING WORK

A. Irrigation System Maintenance & Repair

1. Irrigation shall be done by the use of automatic sprinkler systems, where available and operable; however, failure of the existing irrigation system to provide full and proper coverage shall not relieve the Contractor of the responsibility to provide adequate irrigation with full and proper coverage to all areas in the work site.
2. Any damages to public or private property resulting from excessive irrigation water or irrigation water runoff shall be charged against the contract payment unless immediate repairs are made by the Contractor to the satisfaction of the Owner.
3. The Contractor shall periodically inspect the operation of the system for any malfunction. The Contractor shall maintain all sprinkler systems, in such a way as to guarantee proper coverage and full working capability and make whatever adjustments may be necessary to prevent excessive runoff into street right-of-way or other areas not meant to be irrigated.
4. This periodic inspection may occur more often, but not less frequently, than one inspection per week for turf areas and one inspection per two-week period for slope areas.
5. Contractor will inspect the irrigation system for broken and clogged heads, malfunctioning or leaking valves, or any other condition which hamper the correct operation of the system.
6. Written notice must be given to the Owner a minimum of one week before proceeding with any work not covered by this contract. The Owner retains the option to disapprove the work at any time before it is started. All areas not adequately covered by a sprinkler system shall be irrigated by a portable irrigation method. The Contractor shall furnish all hoses, nozzles, sprinkler, etc., necessary to accomplish this supplementary irrigation. Care shall be exercised to prevent a waste of water, erosion and/or detrimental seepage into existing underground improvements or structures.
7. Controllers shall be programmed, where possible, to water between 9:00 p.m. and 6:00 a.m.
8. Contractor to repair/correct malfunctions of valves, sprinklers and irrigation lines and notify the Owner a minimum of 24 hours in advance of such repairs when at the Owner's expense. Notice will be followed by a written description of repairs/corrections make within four working days of completion of work.

B. Shrubs

1. All plants shall receive sufficient water to insure healthy growth.
2. Weeds shall be removed from beds regularly, by hand. Nut Grass and Bermuda grass and other noxious weeds shall not be allowed to become established.
3. Invasive weeds shall be removed roots and all.
4. Prune to maintain a natural shape as a continuous operation but not when plant is in flower. Branches shall be cut individually. Cuts shall be inside the outline of foliage to thin out. All shrubs growing in the work areas shall be pruned, as required, to maintain plants healthy, growing condition and to maintain plant growth within reasonable bounds to prevent encroachment of passage ways walks, streets, views of signs or in any manner deemed objectionable by the Owner. Dead or damaged limbs or branches shall be removed immediately, and all pruning cuts shall be made cleanly with sharp pruning tools, with no projections or stubs remaining. Any pruning cut which exceeds two inches in diameter shall be sealed with an approved pruning paint. Pruning shall be done in a manner to permit plants to grow naturally in accordance with their normal growth characteristics. Box hedging may be required

on some hedges where authorized by the Owner. Or severe pruning of plants, shall not be permitted.

5. Replacement of plants due to circumstance beyond the Contractor's control shall be at the Owner's expense, provided and installed by the Contractor. Replacement required through negligence of the Contractor shall be at the Contractor's expense.

C. Vines: Vines shall be maintained in their intended form. Pruning shall be performed as a continuous operation so plant will not be allowed to develop a stray, undesirable growth habit. Vines will be trained and attached to buildings, fences, retaining walls, posts, etc., where required once per month using acceptable methods and avoiding damage to structures involved.

D. Ground Cover
1. Watering shall provide enough moisture to penetrate throughout the root zone and only as frequently as necessary to maintain healthy growth.
2. Weeds shall be removed completely, on a regular basis, manually (see weeding schedule above).
3. All ground covers shall be edged back to walks and established boundaries and kept off walks. Trim top growth to achieve an overall, even appearance, renew growth, and improve density and attractiveness.
4. Control rodents, rabbits, insects, snails, and diseases as necessary, using legally approved materials and methods.
5. Dead and missing plants will be replaced at no expense to Owner when due to Contractor's negligence. When damages are due to circumstances beyond Contractor's control, written notice shall be given to the Owner a minimum of one week before plants are to be replaced. Owner shall retain the option to not approve plant replacement before the work is done.

E. Tree Maintenance
1. All trees in the work site shall be maintained in their natural shapes. This work shall be accomplished in a manner which will ensure that each individual tree is trimmed carefully to promote the tree's health and appearance. All work shall be of the highest quality and performed in accordance with approved professional tree trimming standards, and to remove or prevent encroachment where it blocks vision or encroaches in any manner deemed undesirable by the Owner. The Contractor shall be responsible for all tree trimming.
2. Pruning
    a. All trees on the work site shall be maintained in their natural shapes, whether specifically mentioned or not. Trees shall be pruned in a manner to select and develop permanent scaffold branches that are smaller in diameter than the trunk or branches to which they are attached; to provide radial orientation so as not to overlay one another; to eliminate dead, diseased or damaged growth; to eliminate narrow "V" shaped branch forks that strength; to reduce toppling and wind damaged by thinning out crowns; to maintain growth within space limitations and to balance crown with roots.
    b. All pruning cuts shall be made to cambium "collar". "Stubbing" will not be permitted. Use tree scale for cuts one inch or greater in diameter.
    c. Deciduous species shall be pruned during the early spring months.
3. All trees must be watered sufficiently to insure health and growth.
4. Staking and Tying: Trees shall be properly staked and tied, as necessary. Tree ties shall be inspected at least three times a year to prevent girdling of trunks or branches and to prevent bark wounds caused by abrasion. When trees attain a trunk caliper of 4" removal of existing stakes and guys should be considered. If unstable at this time, then replacement should be recommended to Owner.

5. Provide immediate control of insects and diseases following signs of an infestation using approved methods and materials.
6. The Contractor shall bring to the attention of the Owner within twenty-four (24) hours any tree that shows sign of root heaving, leaning, or has hanger limbs, or for any reason is a safety hazard; and the Contractor shall submit a proposal to the Owner for the proper tree maintenance and, with the Owner's approval, proceed with the proposal.
7. The Contractor shall be responsible for the complete removal and replacement of trees lost due to Contractor's faulty maintenance or negligence. Replacement shall be made by Contractor with the size of trees being determined by the Owner. When there is a difference in value between the trees lost and the replacement trees, this difference will be deducted from the Contractor's payment. In all cases, the value of the tree lost will be determined using the latest American Shade Tree Conference guidelines for value determination.
8. Trees lost from causes other than Contractor's negligence shall be removed and replaced by the Contractor with an approved size tree. The Owner may specify a species of tree for replacement different from the one lost.
9. Immediately after every storm, trees shall be visually observed for damage and all trees retied as necessary.

F. Fertilization
   1. Notification: The Contractor shall inform the Owner at least forty-eight (48) hours before beginning any fertilization and shall have previously submitted a schedule of application showing the site, date and approximate time to application of the fertilizer.
   2. Rate and Time of Fertilization
      a. Surface applications of additional fertilizer may be necessary initially or occasionally to encourage new plantings or nitrogen-starved ground cover. As part of the bi-monthly inspection of work the Owner may authorize the Contractor to have a soil analysis done in those areas that need greater attention. The method and areas for taking the soil samples and the laboratory doing the analysis along with recommendations and costs will be submitted to the Owner for approval before additional work is started. Contractor shall blow fertilizer off paved areas such as tennis courts, pool decks, or any other recreation area.

G. Weed Control: All landscape areas within the specified maintenance areas shall be weeded a minimum of once every 30 days or as necessary and shall include all undesirable or misplaced plants.
   1. Removal of all weeds by means of hand removal at regular two-week intervals. Care shall be taken so as not to damage existing ground cover. Any Bermuda grass found within slope or shrub areas, should be eradicated immediately, and replanted with same ground cover in that area.

H. Disease Control
   1. The Contractor shall regularly inspect all landscaped areas for presence of disease, insects or rodent infestation. The Contractor shall advise the Owner in writing within four (4) days if disease, insect, or rodent infestation is found; he shall identify the disease, insects or rodent and specify control measures to be taken. The Owner retains the option to disapprove the work before the work is started. The Contractor shall implement the approved control measures, exercising extreme caution in the application of all spray material, dusts, or other materials utilized.
   2. Approved control measures shall be continued until the disease, insect or rodent is controlled to the satisfaction of the Owner. The Contractor shall utilize all safeguards necessary during disease, insect, or rodent contract operations to ensure safety of the public and the employees of the Contractor.

I. Replacement of Plant Material
   1. The Contractor shall notify the Owner in writing within four (4) days of the loss of plant material due to any cause.
   2. The Contractor shall remove and replace any tree, shrub, turf or ground cover which is damaged or lost due to any cause. The Owner retains the option to disapprove the work before it is started and shall be responsible for replacement costs unless plant material is lost due to faulty maintenance or negligence. The size and species of replacement shrubs, turf or ground cover plants shall be as directed by the Owner. For replacement of trees see article.

3.4 OPERATION OF AUTOMATIC IRRIGATION CONTROLLERS

A. Surrender all keys furnished promptly at the end of the contract period, or at any time deemed necessary by the Owner.
B. Protect the security of the Owner's property by keeping controller cabinets locked at all times.
C. The Contractor shall verify that the weather-based controller is prohibiting operation on rainy weather and when suspension of irrigation is desirable to conserve while remaining within the guidelines of horticulturally acceptable maintenance practices
D. Maintain the controller charts in place (within controller cabinet), and update when required.

3.5 MULCHING:
A. Replace organic mulch and custom gravel rock mulch materials in mulched areas and shrub areas on a monthly basis, as needed, to maintain minimum thickness as specified in Section 329300.

END OF SECTION 320190

# SECTION 328400 – PLANTING IRRIGATION

## PART 1- GENERAL

1.01 RELATED DOCUMENTS
- A. The General Conditions of the contract apply to the work of this section the same as though written herein.
- B. Comply with local and State codes, ordinances, safety orders, and regulations of legally constituted authorities having jurisdiction over this work.

1.02 SCOPE OF WORK
- A. Furnish labor, materials, and equipment to provide, install, and maintain the irrigation system described herein and shown on the Drawings.

1.03 RELATED SECTIONS
- A. Section 31 23 33 – Trenching
- B. Section 32 84 16 – Irrigation Control System
- C. Section 32 91 13 - Soil Preparation
- D. Section 32 93 00 - Plants
- E. Section 32 94 53 – Tree Root Barriers

1.04 REFERENCES
- A. ASTM D 1785 Requirements for Schedule 40 Plastic Pipe
- B. ASTM D 22466 Requirements for Schedule 40 Plastic Fittings
- C. ASTM D 2467 Requirements for Schedule 80 Plastic Fittings
- D. ASTM D 2464 Requirements for Schedule 80 Plastic Threaded Fittings
- E. ASTM D 1869 Requirements for Rubber Ring Gasket
- F. ASTM A 120 Steel Pipe and Fittings
- G. ASTM D 2855 Installation of Plastic Pipe

1.05 SUBMITTALS
- A. Submittals shall conform to provisions of Section 01 33 00. Partial or incomplete submittals are not acceptable and will be returned without a review.
- B. Submit descriptive literature and specifications for the following:
  1. Catalog data for products, equipment, and materials specified herein and as shown on the Drawings.
  2. Substitutions: shall conform to provisions of Section 01 25 00.
- C. Submit photocopies of current NALP registration for foremen performing work on this project.
- D. Equipment or materials installed or furnished without the prior approval of the Architect may be rejected and the Contractor required to remove such materials from the site at his own expense.
- E. Acceptance of item alternate or substitutes indicates only that the products apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted.
- F. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranty shall only supplement the guarantee.
- G. The Architect can at his option require a manufacturer's warranty on product offered for use.

1.06 QUALIFICATIONS AND EXPERIENCE

A. The Contractor shall employ only certified Landscape Industry Exterior Technician Professional with the Oregon Landscape Contractors Association (OLCA), as foremen for irrigation installation work , or must otherwise present ample qualifications for experience with work of similar scope to the satisfaction of the district.

1.07 RESPONSIBILITY

A. Obtain and pay for plumbing permits and inspections required by local jurisdictions.
B. The work performed under this Section is the responsibility of the Contractor. No subcontractor shall relieve the Contractor of his liability to complete the work shown on the Drawings and indicated in the specifications.
C. Protection of public and private property adjacent to the work and exercising due caution to avoid damage to such property. The work shall be protected and maintained throughout the contract period, including during suspension of work, and until final acceptance of the work. Repair or replace damaged improvements including acts of vandalism, theft, and graffiti removal. Repairs or replacements shall be at least equal to original condition of the existing improvement and shall match in finish and dimension.
D. Prior to starting the work of this Section, verify that previously installed work is complete to the point where this installation may properly commence. Verify that work of this Section may be installed in accordance with the design, pertinent codes, regulations, and portions of the referenced standards. In the event of discrepancy, immediately notify the Architect.
E. Locate and mark new and existing underground utilities and equipment shown on as-built drawings and field record drawings of other trades. Review the layout work of this Section with the Architect a minimum of 24 hours prior to commencing with trenching and excavating in these areas. Notify the Architect when utilities not located or marked are found during excavation.
F. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved. Failure to notify the Architect of discovery or damage to unmarked utilities shall result in repair or replacement by the Contractor at no additional cost to the Owner.

1.08 RECORD DOCUMENTS

A. Comply with Section 01 78 39 and General Conditions

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store PVC pipe in a neat and orderly manner, fully supported, and protected from sunlight.

## PART 2 - PRODUCTS

2.01 BRASS PIPE

A. Brass pipe shall be heavy wall type with threads complying to ANSI Specifications.
B. Fitting shall be case brass or case bronze threaded joint and shall comply with ANSI. Specifications. Thread on pipe and fittings shall be tapered type, NPT standard.

2.02 PLASTIC PIPE AND FITTINGS

A. Plastic pipe shall be extruded from 100% virgin polyvinyl chloride (PVC) Type 1, Grade 1 as manufactured by Lasco Industries, Pacific Plastics, John-Manville, or acceptable equal. Pipe shall be new and unused.
B. Plastic pipe shall be continuously and permanently marked with the manufacturer's name, nominal pipe size, PVC 1120, the pressure rating in PSI, and NSF (National Sanitation Foundation)

C. Plastic pipe for non-pressure lateral lines shall be PVC 1120, Schedule 40 unless noted otherwise on the Drawing.
D. Plastic pipe for pressure mainline shall be PVC 1220, Schedule 40 for sizes up to and including 1-1/2 inch, and Class 315 for sizes 2 inch and larger.
E. Plastic fittings for pressure side of valves shall be PVC 1220, IPS Schedule 80. Plastic fittings for non-pressure pipe shall be PVC 1220, IPS Schedule 40, NSF slip fittings and Schedule 40 threaded fittings, as manufactured by Lasco, Pacific, Western, or acceptable equal.
F. Solvent-weld glue shall be Lasco #711 Grey Heavy Body, or acceptable equal. Pressure-side pipe shall be primed with Lasco “Purple Primer” solvent before gluing.
G. Threaded nipples shall be standard weight Schedule 80 molded threads. Threaded nipples exposed above grade shall be gray in color.
H. Pipe for sleeves shall be PVC 1120, Schedule 40, sized as indicated on the Drawings. Provide pull rope 10 feet longer than sleeve.
I. Conduit for flow sensor wires shall be PVC 1120, Schedule 40, grey, sized as indicated on the Drawings.

2.03 THRUST BLOCKS

A. Thrust Blocks shall be minimum 2000 psi concrete, properly sized and formed to fit the fitting or equipment configuration as shown on the Drawings.

2.04 AUTOMOATIC CONTROLLER AND RELATED EQUIPMENT

A. Controller shall be as indicated on the Drawings.
B. Controller enclosure shall be Weathermatic SLPED-ENC-M-1600 Powder-coated metal enclosure with pedestal for SL 1600

2.05 SPRAY AND BUBBLER HEADS

A. Sprinkler heads shall be as indicated on the Drawings.
B. Pop-up sprinkler body shall be as indicated on the Drawings. Where not specifically called-out, pop-up heights shall be 6-inch body type.

2.06 ROTOR HEADS

A. Rotor heads shall be as indicated on the Drawings.
B. Pop-up rotor body shall be as indicated on the Drawings. Where not specifically called-out, pop-up height shall be 6-inch body type.

2.07 CONTROL WIRE AND CONNECTORS

A. Control Wire: shall be PVC insulated, solid copper conductor AWG 14 ga., of type acceptable for direct burial. Pilot wire shall be a single color and the common wire shall be white with a stripe the same color as the pilot wires. Each controller shall be a different color wire. Spare wires shall be black.
B. Master Valve Wire: shall be PVC insulated, solid copper conductor AWG 14 ga. direct burial wire, color different from pilot and spare wires.
C. Flow Sensor Wire: shall be a PVC jacketed two conductor cable. The conductors shall be 16 AWG 7 strand annealed copper, conforming to ASTM B-3 and B-8 with heat and moisture resistant PVC, covered with a .004 wall of stabilizing nylon conforming to UL83 heated at 90 degrees C. The conductor shall be twisted and encased in a single outer jacket of .050 inch minimal wall of sunlight and moisture resistant PVC conforming to UL, ICEA and NEMA standards. The tow conductors shall be color coded with one conductor yellow and the other gray as manufactured by Arizona Electrical Fabricators model #9516-2SP.

D. Control Wire Connectors: shall be Dri-Splice DS-400 as manufactured by the Spears, or acceptable equal.
E. Line Voltage Connections: shall be made by clamp and waterproofed with 3M Company Scotchcast splicing kits or acceptable equal.

2.08 REMOTE CONTROL VALVES
A. Remote control valves shall be as indicated on the Drawings.

2.09 QUICK COUPLING VALVES
A. Quick coupling valves shall be two-piece body designed for working pressure of 125 PSI as indicated in the legend and installed in accordance with detail thereof. Quick coupling valves shall be installed with locking yellow vinyl covers.

2.10 BALL VALVES
A. Ball valves shall be of size, type, and manufacturer as indicated on the Drawings, or acceptable equal.

2.11 GATE VALVES
A. Gate valves shall be of size, type and manufacturer as indicated on the Drawings, or acceptable equal.

2.12 MASTER VALVE
A. Master valve shall be of size, type and manufacturer as indicated on the Drawings. Unless noted otherwise on the Drawings, master valve shall be a normally closed valve.

2.13 CHECK VALVES
A. Check valves shall be as shown on the Drawings.

2.14 FLOW SENSOR
A. Flow sensor shall be of the size, type, and manufacturer as indicated on the Drawings.

2.15 VALVE BOXES AND RELATED MATERIALS
A. Valve box lids shall be green when located in lawn areas; black when located in shrub areas.
B. 12 Inch Rectangular Box and Lid: shall be HDPE plastic type, model #1419-12. Lids shall be model #1419-4B T-Cover Bolt Down, non-hinged, with stainless steel locking bolt, as manufactured by Carson Industries, (800) 735-5566, or acceptable equal.
C. 10 Inch Round Box and Lid: Shall be HDPE plastic type, model #910-10. Lids shall be model #910-4B T-Cover Bolt Down, green color, with stainless steel locking bolt, as manufactured by Carson Industries (800) 735-5566, or acceptable equal.
D. Box lids shall be neatly and permanently heat branded as indicated on the Drawings with pre-formed steel letters/numerals and branding tool into the center of the lid.
E. Base materials for setting valve boxes shall be 1/2” - 3/4” crushed aggregate and 2 x 4 x 8 red brick or concrete brick.
F. Top dressing gravel inside valve boxes shall be ½” – ¾” crushed aggregate.

2.16 BACKFLOW PREVENTION DEVICE
A. Backflow prevention devices shall be of the size and type as noted on the Drawings.
B. Backflow assembly shall be shipped to the job site as a complete assembly, including gate valves and wye strainer.
C. Valve and wye strainer shall be cast bronze construction, and valve shall have resilient wedge gates.

2.17 MARKERS, TAGS, AND SIGNAGE

A. Warning Tape: a detectable 3 inch wide, minimum 5.0 mil, 5 ply composition of ultra high modular weight 100 percent virgin polyethylene, acid, alkaline and corrosion resistant, elongation properties in accordance with ASTM D882-80A and shall be 80 percent MD and 135 percent TD. Tape shall have a minimum 20-gauge solid aluminum foil core, adhered to a 2.55 mil polyethylene backing.
   1. Control Wire Tape - Tape color to be red with black lettering and shall read "Caution: Electrical Line Buried Below". Christy's™ Detectable Marking Tape #TA-DT-3-R-E, T. Christy Enterprises, Inc., (714) 507-3300, or acceptable equal.
   2. Mainline Marking Tape - Tape shall be blue with black lettering and shall read "Caution: Irrigation Line Buried Below". Provide 3-inch tape for mainline up to 4 inches, provide 6 inch tape for mainline larger than 4 inches. Christy's™ Detectable Marking Tape #TA-DT-3-B-I, for 3" tape, #TA-DT-6-B-I for 6-inch tape, T. Christy Enterprises, Inc., (714) 507-3300, or acceptable equal.

B. Valve Identification Tags: shall be polyurethane plastic with and integral attachment neck and reinforced attachment hole. Tags shall be hot stamped with the controller designation letter and valve station number indicated on the Drawings. Tag color shall be yellow with black lettering, Christy's™ Standard Tags, T. Christy Enterprises, Inc., (714) 507-3300, or acceptable equal.

## PART 3 - EXECUTION

3.01 GENERAL

A. The Drawings are diagrammatic, products and equipment are shown at their approximate location and at an appropriate scale for clarity. Detail drawings provide clarification of installation and relationships of the product and equipment to existing conditions and new construction.

B. The installation of irrigation materials shall be coordinated with the landscape planting plans to avoid interfering with the trees, shrubs, or other plantings. Layout sprinkler heads and make minor adjustments as needed to conform to differences between the site conditions and the Drawings. Minor adjustments shall be within the intent of the Drawings and implemented without additional costs to the Owner.

C. Spacing of sprinkler heads are not to be scaled off the Drawings, but located to prevent overspray onto buildings, walks, and structures. Do not willfully install the sprinkler system when it is obvious in the field that obstructions or grade differences exist. Notify the Architect immediately of discrepancies between plans and actual field conditions.

3.02 WATER SUPPLY AND STATIC PRESSURE TESTS

A. Connection to the water supply shall be at the location shown on the Drawings. Installation shall be in accordance with local codes and regulations, and the requirement of the governing water district.

B. Prior to commencing with the work, a static pressure test shall be submitted to the Architect for each point of connection. The test shall be a continuous reading of the static pressure recorded over a 24-hour period. The recorded print out shall be documented with the date and time period the reading was taken. Submit the recorded data to the Architect.

C. When static pressure at a point of connection is below that called out by more than 5 percent, notify the Architect before proceeding with work.

3.03 INSTALLATION

A. Assemblies

1. Threaded pipe and fittings shall be assembled using Teflon tape or equivalent, applied to the male threads only.
2. Assemblies specified herein shall be installed in accordance with their respective detail. In the absence of detail drawings or specifications pertaining to the specific items required to complete the work, the Contractor shall perform such work in accordance with the best standard practice and to the satisfaction of the Owner.

B. Pipe And Pipe Clearances
1. Pressure lines and lateral lines shall have a minimum clearance as indicated on the Drawings. Parallel lines shall not be installed directly over one another. If clearances are not indicated on the Drawings, all clearances shall be per Bend Parks and Recreation District Standard Details and Specifications.

C. Trenching, and Backfilling
1. Trenches: Pipe shall have the continuous support of the trench bottom and shall be laid to an even grade. Trenching excavation shall follow the layout indicated on the drawings and shall be of sufficient width to allow "snaking" of pipe in trench.
2. Backfill for trenching shall be compacted to a dry density equal to the adjacent undisturbed soil in planting areas and 95% under paved areas and shall conform to the adjacent grades without dips, sunken areas, humps, or other irregularities. Initial backfill on lines shall be of a fine granular material with no foreign matter larger than one-half inch in size.
3. If, in the opinion of the Architect, the excavated material is not satisfactory for use as backfill, the Contractor shall dispose of this unsatisfactory material and provide a clean granular fill or sand bedding material. Backfill material shall be placed as indicated on the Drawings.
4. Provide concrete thrust blocks at angles and bends in mainline runs per Drawings.
5. Pressure-side pipe shall be laid with a detectable warning tape 9 inches above the pipe as indicated on the Drawings.
6. Trenches shall be backfilled promptly after the open trench inspection.

D. Pipe Sleeves
1. Sleeves shall of the size and material noted on the Drawings.
2. Sleeves shall extend two (2) feet minimum beyond the edge of paving.
3. Provide permanent pavement marking pin at both ends of sleeve, standard brass survey pin in lead, set 1 inch from edge of paving or walkway.

E. Control Wires
1. Between controllers and remote-control valves, use a continuous wire. Under no circumstance shall splicing exist.
2. Where more than one wire is placed in a trench, the wiring shall be taped together at intervals of ten feet.
3. Wiring shall occupy the same trench and shall be installed along the same route as the pressure supply line wherever possible. Wire bundle shall be placed along the side of mainline pipe. Wire bundles shall not cross over top of mainline.
4. A loop of 12 inches shall be provided at each directional turn in the wire run.
5. Wire shall be laid loosely in trench, not pulled tight. Lay wire so that there is 12 inches of slack for every 100 feet of length.

6. Provide at least 1 extra spare wire for every 3 valves being served by the wire run. Extra wires shall be continuous from controller to end of wire run.
7. Provide sufficient extra wire under valve boxes so that valve can be completely removed from ground and box for servicing without disconnecting wires.

F. Valve Boxes
1. Install valve boxes in accordance with the details thereof.
2. Seal below-grade openings in valve boxes and around piping to prevent soil from entering the valve box. Suitable materials include geotextile fabric, heavy gauge shrink-wrap plastic, or other flexible material accepted by the Architect. Do not use cardboard, duct tape, or other materials that will deteriorate in wet conditions.
3. Keep valve box lids in place during soil preparation to keep soil out. Remove soil materials, which enter the valve box during construction.
4. Where valve boxes occur adjacent to walks, curbs, or headerboard, locate them 6 inches clear from edge of improvement. Where two or more valve boxes occur together, locate them with 6 inches clear between and in a straight row.
5. Install valve boxes so rim is 2 inches above finish grade in shrub areas, 1/2 inch in turf areas.
6. Due to the schematic nature of plans, if questions arise, confirm actual valve manifold locations with Architect before proceeding with work.

G. Sprinkler Heads
1. Install each type of sprinkler head in accordance with the Drawings.
2. Install sprinkler heads 12 inches away from walkway or paving edge; 12 inches away from buildings, above ground utility structures, transformers, and other items.
3. Install sprinkler heads 12 inches away from walls and wood fences.
4. Install sprinkler heads 12 inches away from chainlink fences.
5. Do not locate sprinkler heads where it is obvious, they will spray onto or into utility structures, buildings, signs, controller equipment, or other structures.
6. Install pressure compensating screens as necessary to prevent overspraying onto buildings, walks or utility structures. Choose screens per manufacturer's selection chart.
7. Provide adjustable, part-circle rotor heads when 360˚ full-circle type is not appropriate for the area being irrigated, whether indicated or not on the drawings.
8. Sprinkler heads on slopes shall be set so that they are angled downhill, halfway between plumb and perpendicular to slope angle.
9. Cap or plug all openings as soon as lines have been installed to prevent the entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.
10. Thoroughly flush all water lines before installing valves and other equipment.

H. Pressure Test
1. Pressure lines shall be tested under hydrostatic pressure of 150 PSI, and non-pressure lines shall be tested under the existing static pressure and both be proven watertight. (Contractor to supply equipment needed for testing.)
2. Pressure shall be sustained in the lines for not less than two hours. If leaks develop, the joints shall be replaced and the test repeated until the entire system is proven watertight.
3. Tests shall be observed and accepted by the Architect prior to backfill.

4. Upon completion of each phase of the work, the entire system shall be tested and adjusted to meet site requirements.

I. Flushing the System
1. After valves, lateral lines, and risers are in place and connected, flush entire system, one valve at a time, to clear lines of dirt and debris.
2. Install sprinkler heads, filter screens, and nozzles immediately after flushing operation is completed.

J. Adjusting of System
1. The Contractor shall flush and adjust sprinkler heads for best possible performance and to prevent overspray onto walks, roadways, fences, and buildings.
2. If it is determined that adjustments in the irrigation equipment or nozzle changes will provide proper and more adequate coverage, Contractor shall make all necessary changes, including installation of additional sprinkler heads, or moving sprinkler heads, without additional cost to the Owner, prior to planting.
3. The entire system shall be operating properly before planting operations commence.
4. Lower raised sprinkler heads in lawn areas within ten days after notification by the Architect.

3.04 TURNOVER EQUIPMENT
A. The Contractor shall provide 2 sets of sprinkler wrenches for adjusting, cleaning, or disassembling each type of sprinkler.
B. Provide 2 each of special tools required for other equipment.
C. Provide 2 keys for each automatic controller.
D. Provide 2 quick coupler keys for each type of quick-coupler valve used.
E. Two service manuals and information pages for equipment used shall be furnished to the Owner. Manuals shall be loose leaf in 3-ring binders and should show drawings or exploded views of equipment and catalog number. Operating instructions for equipment shall be furnished.

3.05 REVIEW OF WORK
A. Installations and operations are to be reviewed and accepted by the Architect.
B. In no event shall the Contractor cover-up or otherwise remove from view work under this contract without prior acceptance of the Architect. Work covered prior to review shall be uncovered by the Contractor at no additional cost to the Owner. The Contractor shall request a review by the Architect at least two days in advance. Reviews will be required for the following:
1. Mainline pressure test and installation prior to backfilling
2. Coverage test upon sprinkler system completion and prior to planting
C. Materials and equipment required for testing of the system shall be provided by the Contractor at no additional cost to the Owner.

3.06 RECORD DRAWINGS
A. The Contractor shall maintain a complete and accurate set of project record Drawings. The Drawings shall be kept up to date with the progress of the work in accordance with Section 01780.
B. Contractor shall provide adequate measurements and field notes for preparation of accurate "project record" drawings. Show either actual locations or dimensions form two

permanent points of reference such as building corners, curbs, sidewalk, intersections, etc. (but not from irrigation equipment) locations of the following:

1. Connections to water sources
2. Water meters
3. Routing of main lines
4. Location of both ends of sleeves
5. Remote control valves
6. Quick coupler valves
7. Backflow prevention devices
8. Gate valves
9. Routing of control wiring
10. Controllers

C. Record Documents accurately record locations of new piping and equipment horizontally to within one (1) foot and vertically to within 0.5 feet.

D. The completed and accepted reproducible record drawings and record job set blueprints shall be delivered to the Owner on or prior to the final inspection.

## 3.07 CONTROLLER CHARTS

A. Project record drawings shall be prepared by the Contractor before charts are prepared.

B. Provide one controller chart for each controller supplied.

C. The chart shall show the area controlled by automatic controller and shall be the maximum size controller door will allow.

D. The chart is to be reduced drawing of the installed system. However, in the event the controller sequencing is not legible when the drawings is reduced, it shall be enlarged to a size that will be readable when reduced. If controller sequencing has been changed from the original drawings, the new sequencing shall be indicated on the controller chart.

E. Chart shall be non-fading blackline print and a different color shall be used to show area of coverage for each valve station.

F. The chart shall be mounted using Velcro, or an approved equal type of comparable quality.

G. When completed and accepted, the chart shall be laminated between two pieces of clear plastic, each piece being a minimum of 20 mils thick.

H. Charts shall be completed and accepted prior to final acceptance of the irrigation system.

I. Controller chart shall include the following information:

1. Color-coded area of coverage for each valve.
2. Valve size, station number, and controller designation.

## 3.08 CLEAN-UP AND REPAIR

A. Upon completion of the work, make the ground surface level, remove excess materials, rubbish, debris, etc., and remove construction and installation equipment from the premises.

B. Replace and/or repair to the satisfaction of the Architect existing paving disturbed during the course of this work. New paving shall be the same type, strength, texture, finish, and be equal in every way to the material removed.

C. Contractor will be responsible for all maintenance and repair of entire irrigation system, including vandalism and theft, until final acceptance.

## 3.09 FINAL INSPECTION

A. The Contractor shall show evidence to the Owner's Representative that the Owner has received required accessories, charts, record drawings, etc., before final inspection can occur.

B. Notification by the Contractor shall be made in writing to the Owner seven days prior to final inspection. The final inspection of the work shall be made in the presence of the Owner's Representative at the time the work is completed.

3.10 GUARANTEE

A. The entire sprinkler system shall be guaranteed by the Contractor as to material and workmanship, including settling of backfilled areas and trenches for a period of one year following the date of final acceptance of the work.

B. Should operational difficulties in connection with the sprinkler system develop within the specified guarantee period, which in the opinion of the Owner may be due to inferior material and/or workmanship, said difficulties shall be immediately corrected by the Contractor to the satisfaction of the Owner, at no additional cost.

3.11 TEMPORARY REPAIRS

A. The Owner reserves the right to make temporary repairs as necessary to keep the sprinkler system equipment in operating condition. The exercise of this right by the Owner shall not relieve the Contractor of his responsibilities under the term of the guarantee as herein specified.

END OF SECTION 328400

# SECTION 329113 – SOIL PREPARATION

## PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The General Conditions of the contract apply to the work of this section the same as though written herein.

1.02 SCOPE OF WORK

A. Furnish labor, materials, and equipment to place imported topsoil, prepare soil for planting, and to finish grade as described herein and upon the drawings.

B. Work not included: Rough grading and storm drainage.

1.03 RELATED SECTIONS

A. Section 32 84 00 – Planting Irrigation

B. Section 32 93 00 – Plants

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM)

B. American Association of State Highway and Transportation Officials (AASHTO)

C. Standard Specifications for Public Works Construction, latest edition (Greenbook)

D. Bend Park and Recreation District Development and Design Standards, 2020.

1.05 SUBMITTALS

A. Product Submittals – Submit the items identified below following the procedures prescribed under Section 01 33 00 Submittals. Partial or incomplete submittals are not acceptable and will be returned without a review.

1. Organic soil amendments – Submit samples and product specifications not more than 30 days old. Specification shall include particle size evaluation, total nitrogen (N), ammonia (NH4-N, nitrate (NO3-N), ECe, pH, micronutrients, and metals.
2. Inorganic conditioners, fertilizers, and chemicals – Submit product literature and specifications.
3. Topsoil – Submit sample and product analysis.
4. Agricultural Soil Tests – Submit analysis report and recommendations for soil samples.

B. Submit photocopies of current NALP certification for foremen performing work on this project.

C. Costs for sampling, testing or inspection of materials are included in bid, and copies of inspections, certificates, and tests results shall be furnished without additional cost to the Owner.

D. Substitutions – For materials that differ from a specified brand or product, submit samples, product specifications, and product literature. Follow procedures as prescribed under Section 01 25 00 Substitutions.

1.06 EXPERIENCE AND QUALIFICATIONS

A. The Contractor shall employ only certified Landscape Industry Exterior Technician Professional with the Oregon Landscape Contractors Association (OLCA), as foremen for irrigation installation work, or must otherwise present ample qualifications for experience with work of similar scope to the satisfaction of the district.

1.07 RESPONSIBILITY

A. The Contractor shall be responsible for the protection of public and private property adjacent to the work and shall exercise due caution to avoid damage to such property. The work shall be protected and maintained throughout the contract period, including during suspension of work, and until final acceptance of the work. Contractor shall repair or replace damaged improvements including acts of vandalism, theft, and graffiti removal. Repairs or replacements shall be at least equal to original condition of the existing improvement and shall match in finish and dimension.

B. Prior to starting the work of this Section, verify that previously installed work is complete to the point where this installation may properly commence. Verify that work of this Section may be installed in accordance with the design, pertinent codes, regulations, and portions of the referenced standards.

C. In the event of discrepancy, immediately notify the Landscape Architect.

D. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.

**PART 2 - PRODCUTS**

2.01 SOIL AMENDMENTS

A. Organic Soil Conditioner- Humic Compost

1. Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
   a. pH of 5.5 to 8
   b. Moisture Content: 35 to 55% by weight
   c. Organic Matter Content: 30 to 40% of dry weight
   d. Particle size requirement: ¾ inch
   e. Particle size: Minimum of 98% passing through a one-inch sieve

B. Humate Plus

1. A commercially mined and packaged soil conditioner containing 40 percent organic matter, 40 percent Carbon, and 40 percent humic acids. Manufactured by Tri- C Enterprises, Chino, CA, (800) 927-3311.

C. Agricultural Gypsum

1. A commercially processed and packaged product with a minimum 90 percent Calcium Sulfate dihydrate ($CaSO_4 2H_2O$) and minimum 14 percent Sulfur (S). Gypsum shall be free flowing, fine granular form with 100 percent passing a 10-mesh screen. Product shall be environmentally safe and produced specifically for agricultural or landscape use.

D. Granular Fertilizer

1. Fertilizer shall be a commercial grade product, uniform and homogenous in composition, dust free, dry, and free flowing granular or pelletized form suitable for application with approved equipment, and shall contain the following minimum available percentages by weight of plant food:

| | |
|---|---|
| Nitrogen | 6.00% |
| Phosphorus | 20.00% |
| Potassium | 20.00% |

2. Fertilizer shall be delivered to the site in original unopened containers bearing the manufacturer's guaranteed analysis. Wet or caked fertilizer is not acceptable.

E. Refer to section 32 93 00 Plants for additional soil amendments used at planting pits including fertilizer tablets and mycorrhizal incoculum.

2.02 PRE-EMERGENT HERBICIDES

A. Pre-emergent herbicides shall be a wettable powder or granule type product, suitable for use with the groundcovers specified on the plans and suitable for use with the on-site soil.
B. Herbicides shall be selected for controlling the weeds indigenous to the site.
C. Herbicides shall comply with requirements of local and state agencies having jurisdiction over the project.

2.03 AMENDMENTS FOR BID

A. Amendments are for bidding purposes only. Quantity and procedure adjustments will be made per the Agricultural Soil Analysis report and recommendations. Contractor shall send the report to the Landscape Architect for review. Adjustments by the Landscape Architect will be issued in writing. The following amendments and quantities are to be used as the basis for bids:
   1. Soil amendments for planting areas with gradient less than 2:1 in slope. Quantity per 1,000 square feet:
      4 cu. yds. Organic soil conditioner
      10 lbs. Humate Plus
      5 lbs. Granular fertilizer
      25 lbs. Agricultural gypsum
   2. Refer to Section 32 93 00 Plants for bid amendments for plant pit backfill mix.

2.04 IMPORTED TOPSOIL

A. Imported soil shall be Class A topsoil as defined under Section 212-1.1.2 of the Standard Specifications. Provide soil free of subsoil, brush, objectionable weeds, seeds, rocks, organic or inorganic debris, silt, and clay, toxic substance, organic or inorganic; soil sterilants; salts; and soil removed from roadbed excavations.
B. The Contractor shall furnish upon the request of the Landscape Architect a soils report made from the intended import by an approved agricultural lab. The report shall include pH, N-P-K, SAR, minerals, micro-nutrients, ECe, boron levels, soil particle size, and textural elevation. Soil imported to site and found to be unsuitable by the Landscape Architect shall be removed from the site and replaced with an approved soil at the Contractor's expense. The Contractor shall pay expenses for soil testing of import materials.

## PART 3 - EXECUTION

3.01 GENERAL

A. Planting operations shall not commence until completion of construction work, grading, soil preparation, weed control, and sprinkler installation.
B. Irrigation system shall be fully operational including automatic controller, before commencing planting operations.

3.02 AGRICULTURAL SOIL TESTING

A. The Contractor is responsible for correction of soil pH, nutrient levels, and chemical balance until final acceptance by the Owner.
B. Upon completion of rough grading and topsoil placement, soil samples shall be taken from three separate locations and submitted to a soil analysis laboratory. Separate results shall be provided for each of the 3 samples, with each having its own individual letter or number to identify it. Include with the samples, a description of the proposed planting, a reduced scale site plan showing where each sample was taken with its letter or number shown, and the type of organic amendment to be used.

C. The analysis report shall include pH, N-P-K, SAR, ECe, boron levels, percolation rates, and soil particle size and textural evaluation. The report shall include recommendations for amendments, fertilizers, application rates, and procedures for conditioning the soil.
D. The Landscape Architect shall review the analysis reports prior to ordering amendments.
E. A pre-approved laboratory offering soil testing services is: Waypoint Analytical, 1101 S. Winchester Blvd. Suite G-173, San Jose, CA 95128, p (408) 727-0330.
   1. Soil test shall be #A05-2 complete evaluation for new planting. The report shall address turf, groundcover, tree and shrub backfill conditions.
F. Report substitutions are not permitted unless pre-approved by the landscape architect. Contractor will be required to submit a sample soil test results and recommendations for a substitution request. If a substitutive laboratory is used and the landscape architect deems the report unsatisfactory, the contractor shall acquire a new report at no cost to the owner.

3.03 PERCOLATION TESTS
A. Test for percolation prior to sending soil sample to analysis laboratory.
B. Auger two (2) holes two (2) feet deep at locations determined by the Landscape Architect. Fill holes with water to one half the depth of each hole. Let drain.
C. Once holes have drained, fill holes again to one half the depth of each hole.
D. Record drop in water level at thirty (30) minute intervals for maximum of six hours (6) or until the water has percolated.
E. When the percolation rate is one half (½) inch per hour or less, notify the Landscape Architect. Alternative will be requested with cost for improving percolation and drainage of the planting area.

3.04 TOPSOIL PLACEMENT
A. Refer to the Drawings for areas to receive, and the depth of topsoil.
B. The topsoil shall be placed in maximum 6-inch lifts with the first lift placed and tilled into the top 6 inches of the existing soil. Prior to placing each lift, the area shall be thoroughly moistened but not saturated. Each succeeding lift shall be placed and compacted to until the finished grades indicated on the drawings are achieved.
C. The finished grades shall be free of depressions, humps, rocks, debris, air pockets, and ready to receive soil amendments.

3.05 INITIAL WEED ABATEMENT
A. In areas designated to receive amendments, irrigate normally for two weeks to germinate weed seeds. Apply broad spectrum non-selective herbicide per manufacturer’s instructions.
B. Repeat the application of herbicide when weeds remain, or new weeds appear one (1) week after initial application.
C. Clear and grub dead weeds and organic debris prior to commencing topsoil placement or soil preparation.

3.06 SOIL PREPARATION
A. Manually remove weeks as described above in Initial Weed Abatement.
B. In planting areas with a gradient less than 2:1, mechanically rip or hand till the area in two directions to a minimum depth of 6 inches.
C. Remove rock and hard clods 3 inches in diameter and larger, remove construction debris, roots, stumps, trash and other deleterious materials from the top 6 inches of soil.
D. Apply soil amendments, fertilizers, and conditioners evenly and at the specified application rates.
E. Rototill top 6 inches of soil to a loose and friable consistency.

F. Fine grade to contours and spot elevations shown on Drawings.

3.07 LANDSCAPE FINISH GRADING

A. Finish grading shall establish flow lines and gradients for uniform water drainage. Flow lines and gradients shall be established from the high point to the drainage structure or outfall area. Finished grades shall be of uniform slope and grade between points of fixed elevations or elevation controls. Flow lines shall have a minimum 2 percent gradient from highpoint to inlet or outfall area. Contractor shall notify the Landscape Architect when grades or flow lines conflict with other construction or when positive drainage is not achievable and request a resolution. Failure to report the conflicts prior to planting shall result in removing the plant material, re-grading to correct the discrepancy and replacement of the plant material at no cost to the Owner.

B. Unless noted otherwise, finished grades along walkways and curbs shall maintain a constant relationship between the finished paving and finished grade. Finished grade for lawn areas shall be 1 inch below sidewalks and curbs. Finished grades for mulch or ground cover areas shall be 2 inches below sidewalks and curbs.

C. Finished grades shall be floated to a uniform surface free of irregular dips, humps, valleys or ridges. Refer to Section 02925 for additional requirements for preparing lawn areas.

D. The finished grades shall maintain drainage away from buildings, structures, walls, paving, and towards drain inlets or outfall areas. Flow lines shall be established to drain water from behind walls and towards drain structures.

E. When no compaction rate for planting areas is specified geotechnical report or when no report is available, compact turf and groundcover areas a minimum 85 percent to a maximum 90 percent relative density or as shown on drawings or specified elsewhere.

3.08 SECOND WEED CONTROL

A. After completion of Soil Preparation and finish grading commence irrigation of all plant beds, lawns, and lawn repair areas. Inspect planting areas if weeds are present apply broad spectrum herbicide.

B. Wait ten days minimum and inspect all plant beds and lawn areas for the presence of any additional weds. If weeds are present, apply a second application of broad-spectrum herbicide to affected areas and delay planting until all weeds are dead.

END OF SECTION 329113

# SECTION 329220 – NATIVE SEEDING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes requirements for the installation of native grass seed and specified mulch, straw matting if applicable, and maintenance of the seeded areas is achieved as outlined in Article 1.10, “Maintenance”.

B. Related Sections:
1. Section 329300 – Plants
2. Section 329113 – Soil Preparation
3. Section 328400 – Landscape Irrigation

### 1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Herbicide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, herbicide, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

F. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. Weeds: Including but not limited to Scotch Thistle, Perennial Pepperwood, Yellowflag Iris, Knapweed, Poision Hemlock, White Top, Puncture Vine, Dalmation Toadflax, Orange Hawkweed, Cheat Grass.

### 1.4 REFERENCES

A. Comply with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and be equal to or better in quality than the standards for Certified Seed.

B. Oregon Department of Transportation (ODOT) – Standards Specifications for Road and Bridge Construction.

1.5 SUBMITTALS

A. See Division 01 Section “Submittals” for submittal requirements.

B. Product Data: For each product indicated.

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.

D. Qualification Data: For qualified landscape Installer.

E. Maintenance Instructions: Recommended procedures for maintenance of turf and dryland grasses during a calendar year. Submit before expiration of required initial maintenance periods.

F. The Landscape Architect reserves the right to reject the seed at any time prior to acceptance and that fails to meet specification requirements. Promptly remove rejected seed from the site.

1.6 QUALITY CONTROL

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf and dryland grass establishment.

B. Soil Analysis: Section 329113 Soil Preparation.

C. Preinstallation Conference: Conduct conference at Project site to coordinate the process with other trades, to coordinate equipment movement within planting areas and to avoid soil compaction, to review proposed methods of installation, performance criteria, and maintenance procedures. Review underground utility location maps and plans. This meeting shall be coordinated by the Contractor and comply with requirements in Division 01.

D. Standards: All materials and methods used during this portion of the work shall meet or exceed applicable federal, state, county, and local laws and regulations. All seed shall be free from insects and disease. Species shall be true to their scientific name as specified.

E. Materials: The Contractor shall submit to the Landscape Architect for approval a complete list of all materials to be used during this portion of the work prior to delivery of any materials to the site. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the Landscape Architect.

F. Plant species substitutions shall be submitted to and approved by the Landscape Architect prior to construction.

G. All native grass species shall be supplied as pure live seed. Submit to the Landscape Architect lab germination test results for all grass species. Submit an affidavit that describes estimated purity for all forb species that are not typically tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and other Packaged Materials: Deliver seed and packaged materials in original unopened containers bearing weight, analysis and name of supplier. Store in a manner to prevent the materials from becoming wet and deteriorating.

B. Fertilizer: Deliver organic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.

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 fertilizers and soil amendments with appropriate certificates.
   4. Seed: Deliver seed materials in original unopened containers, showing bearing weight, analysis and name of supplier. Store in a manner to prevent the materials from wetting and deterioration.
   5. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.

D. Material will be inspected upon arrival at project site. Landscape Architect will reject any opened or unacceptable materials as described above.

E. Immediately remove unacceptable material from job site.

1.8 PROJECT/SITE CONDITIONS

A. Work scheduling: Proceed with and complete landscape work as rapidly as portions of the site become available, working within the specified planting season and approved schedule.

B. Planting Restrictions: Planting is preferred in spring but may be performed through September. Coordinate seeding with initial maintenance periods to provide required maintenance from date of Substantial Completion.

C. Vehicular accessibility on site shall be as directed by Landscape Architect. Repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the City.

D. Do not drill or sow seed during windy, rainy weather or when ground is frozen or otherwise unable to be tilled.

E. Seeding Season: Seeding shall occur between April 1st and October 1st.

F. Existing conditions:
   1. Existing Plants: Install seed only after all irrigation items have been installed and accepted by the Landscape Architect.
   2. Utilities: Determine location of underground utilities. Perform work in a manner to avoid possible damage. Hand excavate, as required.
   3. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Landscape Architect before planting.

4. If weeds are present on site, treat with herbicide prior to preparing soil for installing seed as specified below.

G. Coordination:
1. Coordinate with construction of utilities on site. Do not begin placing topsoil until underground work is completed in the area.
2. Coordinate with seeding and landscape Contractor(s) approved schedule. Limit construction access to areas where topsoil has been placed if placement is completed more than three (3) days prior to commencement of landscaping in the area. Limit fine grading to areas that can be prepared for planting within twenty-four (24) hours after fine grading.
3. Coordinate with Contractors work requiring access to site over seeded areas.
4. Coordinate with installation of underground irrigation system.

1.9 WARRANTY

A. Warranty for Native Seed Areas: Warrant areas in seed to be in a healthy, vigorous growing condition, and for consistency and completion of coverage for a period of two (2) years from date of substantial acceptance as a full stand of grass. After seed germination, re-seed any spots where seed has not germinated within the total seeded area. Continue this procedure until a successful stand of grass is growing and accepted by the Landscape Architect.
1. During the original warranty period, reseed at once with comparable blend/mix, those areas that have failed to achieve a stand of grass or which in the Landscape Architect's opinion are unhealthy.
2. Reseeding will not be allowed in any season considered unfavorable for seeding by the Landscape Architect.
3. Reseed in a manner to achieve quality as originally specified.

1.10 MAINTENANCE

A. General: The maintenance period shall begin immediately after each area is seeded and continue until Final Acceptance of entire project. Final Acceptance of seeded areas will not be given until Landscape Architect is satisfied with germination and a full stand of grass, in a vigorous growing condition, with consistent and complete coverage. During this time, be responsible for watering, mowing, spraying, weeding, fertilizing and all related work as necessary to ensure that seeded areas are in a vigorous growing condition. Provide all supervision, labor, material and equipment to develop and maintain seeded areas. After Final Acceptance, maintenance shall become the responsibility of the Owner.

B. Non-irrigated Areas: The seeded areas shall be accepted on the basis of showing evidence of growth of specified seed material over the entire seeded area within three (3) months of seeding during weather conditions that are favorable for seed germination and growth.

C. Mowing and Trimming: Mow native grasses after the grass has gone to seed, cutting back to not less than four-inches (4") in height. Remove clippings from adjacent pavement or irrigated planting areas and remove from site.

D. Fertilizing: Within forty-five (45) days of seeding and every sixty (60) days thereafter until final acceptance, apply specified fertilizer to maintain optimal turf vigor or per the direction of the Landscape Architect.

E. Weed Control: Control annual weeds by mowing prior to seed development. Control perennial weeds through use of selective herbicides approved by the Landscape Architect only after grass stand has matured sufficiently that it will not be harmed by application of herbicides. Any plant material that is harmed due to over spraying, wind drift or improper application shall be replaced by the Contractor at no cost to the City.

F. Insect and Disease Control: As needed, apply insecticide and fungicide approved by the Landscape Architect.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Soil Preparation: See 329113 Section “Soil Preparation.

B. General:

1. All seed mixes shall be obtained from Helena Agri-Enterprises, LLC., 20512 Nels Anderson Place, Building 3 Suite E, Bend, OR 97701, phone 541-385-7001.
2. All seed shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, the lot number, net weight, origin, the percent of weed seed content, the guaranteed percentage of purity and germination, pounds of pure live seed (PLS) of each seed species, and the total pounds of PLS in the container. All brands shall be free from Oregon prohibited noxious weed. The Contractor shall furnish to the Landscape Architect a signed statement certifying that the seed is from a lot that has been tested by a recognized laboratory for seed testing within six months prior to the date of delivery. Seed that has become wet, moldy or damaged in transit or in storage will not be acceptable.
3. Computation for quantity of seed required on the project is based on Pure Live Seed (PLS).

C. Seed Mixes: As shown on the Drawings

D. Soil Amendment: Per section 329113

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber; 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.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant growth or germination inhibitors.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
1. Verify that finish grades are consistent with the slopes and grades indicated on the Contract Drawings.
2. 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.
3. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
4. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
5. Uniformly moisten excessively dry soil that is not workable, and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Landscape Architect.

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.

D. Acceptance: Beginning of installation means acceptance of existing conditions by the Contractor.

3.2 PROTECTION

A. Protect existing utilities, paving and other facilities from damage caused by seeding operations, Contractor shall repair any damage at no additional cost to the Owner.

B. Restrict vehicular and pedestrian traffic from seeded areas until grass is established.

C. Locate, protect and maintain the irrigation system during seeding operations. Repair irrigation system components damaged during seeding operations shall be replaced or repaired at Contractor's expense.

D. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

3.3 PREPARATION

A. Work notification: Notify the Landscape Architect at least seven (7) working days prior to start of seeding operations.

B. Utilize equipment having low unit pressure ground contact within planting areas.

C. Limit preparation to areas that can be seeded within 24 hours of preparation.

D. The Contractor shall prepare the soil of all areas to be seeded with Prairie Mix in accordance with the requirements of Division 32 Section "Soil Preparation". When completed, the soil shall be firmed by float dragging, followed by steel raking, to provide for the proper seeded surface. The seed bed shall be totally free from rock or clay clods over 1-inch in diameter.

E. Fine Grading: Maintain positive drainage, prevent ponding and direct run-off into catch basins, drainage structures, etc., and provide well-contoured surface prior to proceeding. A firm weed-free seed bed is required. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations. Obtain Landscape Architect's approval of finished grade prior to proceeding with seeding operations.

1. Protect adjacent and adjoining areas from hydromulching overspray.

2. Protect grade stakes set by others until directed to remove them.

F. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

G. Verify that all areas are graded to drain at a minimum of two percent (2%) or as indicated on the Contract Drawings. Verify that subsurface drainage system and drain inlets if any, are operative.

H. Verify that irrigation system is operable and provides adequate coverage prior to planting.

3.4 INSTALLATION

A. Seed within twenty-four (24) hours after preparation of seed bed. Seeding at other times may only be done if approved by the Landscape Architect.

B. Areas outside Contract Limits disturbed as a result of construction operations shall be seeded at Contractor's expense.

C. Hydroseeding: Mix specified seed 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 wit fiber-mulch manufacture's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1500-lb/acre.

D. Areas not properly hydroseeded, or any damage that may occur during construction is the responsibility of the Contractor and shall be repaired and re-seeded in an acceptable manner at the Contractor's expense. Hydroseeding removed by wind, rain or other causes prior to acceptance shall be re-established by the Contractor at his own expense.

E. Contractor shall remove all hydroseeding from any surface area not specified for seeding, including but not limited to plant materials, fences, paved areas, signs, mulch beds, irrigation components and all other objects as directed by the Landscape Architect.

3.5 DRYLAND GRASS MAINTENANCE

A. Maintain and establish dryland grass seed areas by weeding, mowing, trimming, replanting, watering and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a full coverage stand of grass. 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 meadow 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 meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of herbicides and reduce hazards.

B. Watering: Contractor shall water dryland seeded areas to obtain establishment of an acceptable grass stand, and to supplement natural moisture levels during dry periods.
1. Water dryland grasses with fine spray at a minimum rate of one-half-inch (1/2") per week for six (6) weeks after planting unless rainfall precipitation is adequate.
2. Do not over-water in a manner which kills drought-tolerant components of the seed mix.
3. Contractor is responsible for providing all water and equipment necessary.

C. Mowing: Allow to grow to a minimum height of twelve-inches (12") prior to mowing. Cut no more than four-inches (4") at a cutting. Monitor weed growth and mow to prevent seed distribution. Mow monthly during the first season.
1. Year One: Mow the planting area 2-4 times during the early growing season to a height of six-inches (6") to eight-inches (8"). Mowing prior to or when non-native and weedy species are flowering to prevent seed-set. Control undesirable plant species by hand-pulling prior to the development and maturation of the plant. Hand-removal shall include the removal of all above-ground and below-ground stems, roots and flower masses prior to the development of seed. If necessary, Round-up herbicide may be selectively applied by a licensed applicator trained in plant identification at no additional cost to the City. Ob-

tain Landscape Architect's approval prior to applying herbicide. Apply per manufacturer's instructions.

2. Year Two, or longer period as arranged with Landscape Architect: Control undesirable plant species as necessary by mowing, hand-pulling, selective herbicide application, and/or prescribed burning.
3. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
4. 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 herbicides and reduce hazards.

## 3.6 SATISFACTORY DRYLAND GRASSES

A. Dryland grass seed installations shall be minimally established to meet the following criteria by Substantial Completion as determined by Landscape Architect:
   1. Within three (3) months, total vegetation cover in all zones seeded with cover crop shall exceed seventy percent (70%) by aerial cover. Dryland grass shall be free of weeds, foreign grasses, disease and harmful insects.
   2. By the end of the first full growing season after seeding, total vegetation cover including cover crop shall exceed ninety percent (90%) by aerial cover and ten percent (10%) of all species present shall be native.
   3. By the end of the first full growing season, seedling from 20% of planted forb species shall be present.
   4. At any time during the contract period no more than ten percent (10%) by aerial cover of the seeded area should be dominated by aggressive exotic species
   5. Until final acceptance seeded areas that fail after having been replaced previously, shall be replaced until it meets establishment as required above. Replacement materials shall be identical to those originally specified. Provide seed tags to the Landscape Architect for verification.
   6. Remedial action: If seeded areas greater than ten (10) square feet fail to meet the terms of the guarantee shown above, the Landscape Contractor will develop and submit to the Owner's Representative a remedial action plan that takes into consideration the site goals and specific deficiencies causing the remedial action. Contractor will implement the remedial action plan and submit a report that describes the remedial action taken. If remedial seeding or planting is required, Contractor will not be required to perform additional remedial seeding or planting in the same area for a minimum of two growing seasons. After two growing seasons following the remedial planting, the performance criteria must be met for the second growing season or additional remedial action must be taken. This guarantee remains in effect until all zones meet the third growing season criteria.
   7. Seeded areas will not be accepted in parts. Each time any portion or section of the entire seeded area requires replacement or remedial action, the maintenance period shall extend until all seeded areas meet the minimum establishment requirements stated above.
   8. All expense incurred including repairs from vandalism for the replacement and or establishment of the seed areas are the responsibility of the Contractor.
   9. If seeded in the fall, review for establishment shall be no later than June 15 of the following year.

## 3.7 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from all excess materials, debris and equipment from site. Repair any damage resulting from seeding operations.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 329220

# SECTION 329300 – PLANTS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Conditions of the contract apply to the work of this section the same as though written herein.

1.2 SCOPE OF WORK

A. Furnish labor, materials, and equipment to provide, and install and maintain trees, shrubs and groundcovers as described herein and upon the drawings.

1.3 RELATED SECTIONS

A. Section 328400 – Planting Irrigation
B. Section 329113 – Soil Preparation
C. Section 329219 – Turfgrass Seeding

1.4 REFERENCE STANDARDS

A. American Standard for Nursery Stock – ANSI Z60.1 – 2004
B. Sunset Western Garden Book – latest edition

1.5 SUBMITTALS

A. Submittals shall conform to provisions of Section 01 33 00. Submittal package shall include all products and materials related to the work of this Section. Partial or incomplete submittals will not be accepted and will be returned without a review.
B. Submit descriptive literature and specifications for the following:
   1. Plant material list of trees, shrubs, and groundcovers to be furnished; include name of supplier or nursery source.
   2. Weed abatement herbicides, product literature and specifications
   3. Staking, tying, guying, and erosion control products
   4. Fertilizers, conditioners, and backfill products
   5. Organic and inorganic mulch
C. Submit photocopies of current NALP certification for foremen performing work on this project.
D. Submit photographs for each species of tree and for shrubs 15 gallon or larger. Photographs shall be of an individual plant with the size, shape and structure clearly defined. The plant material in the photo shall be a representative example of the entire quantity being supplied.

1.6 SUBSTITUTIONS

A. Follow procedures as outline under Section 012500 Substitutions.
B. Products: When a brand name is called for on the Drawings or in these specifications, submit a letter describing the purpose for the substitution and include the product literature and specifications of the substitution.
C. Plant Material: When a plant specie is shown to be unavailable in the size or quantity specified, a substitution will be considered provided the substitute materials are reviewed and accepted through the submittal process. Except for the variations so authorized, substitute plant materials shall conform to the requirements of these specifications. If the accepted substitute materials are of less value than those indicated or specified, the contract price will be adjusted in accordance with the provisions of the contract.

1.7 QUALIFICATIONS AND EXPERIENCE

A. The Contractor shall employ only certified Landscape Industry Exterior Technician Professional with the Oregon Landscape Contractors Association (OLCA), as foremen for irrigation installation work, or must otherwise present ample qualifications for experience with work of similar scope to the satisfaction of the district. .

B. Sampling, testing, or inspection costs of material required by local or state agencies are to be borne by the Contractor, and copies of inspection certificates shall be furnished without additional charge.

1.8 RESPONSIBILITY

A. The Contractor shall be responsible for the protection of the work and the public and private property adjacent to the work and shall exercise due caution to avoid damage to such property. The work shall be protected and maintained throughout the contract period, including during suspension of work, and until final acceptance of the work. Contractor shall repair or replace damaged improvements including damages from acts of vandalism, theft, and graffiti removal. Repairs or replacements shall be at least equal to original condition of the existing improvement and shall match in finish and dimension.

B. Prior to work of this Section, verify that previously installed work is complete to the point where this installation may properly commence. Verify that work of this Section may be installed in strict accordance with the original design, pertinent codes, regulations, and portions of the referenced standards.

C. In the event of discrepancy, immediately notify the Architect.

D. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.

## PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. Nomenclature: Plant species' names shall be per the latest edition of Sunset Western Garden Book. Botanical names shall take precedence over common names.

B. Plant material size and quality shall conform to standards established by American Standard For Nursery Stock, ANSI 260.1-2004, May 12, 2004 Edition.

C. Conditions: Plants shall be symmetrical, typical for variety and species, sound, healthy, vigorous, free from plant disease, insect pests or their eggs, excessive abrasions or other objectionable disfigurements, and shall have healthy, normal root systems, well-filling their containers, but not to the point of being root bound. Tree trunks shall be sturdy and well hardened-off. Plants shall not be pruned prior to delivery except as authorized by the Architect.

D. Ground cover plants shall have been grown in flats and shall remain in those flats until time for transplanting. At time of transplanting, the flat soil shall contain sufficient moisture so that the soil does not fall apart when lifting plants from flat. Each plant shall be planted with its proportionate amount of the flat soil in a manner that will ensure a minimum of disturbance to the root system. Plants shall be fully developed and shall be filling the flat.

E. In no case shall trees or shrubs be topped or pruned within 6 months prior to delivery. Plants shall be grown by nurseries that have been inspected by the State Department of Agriculture and have complied with its regulations.

F. Identification: Plants shall be of the variety and size shown on the drawings and shall conform to the requirements herein. One of each bundle or lot shall be tagged with plant name in accordance with recommendations of the American Association of Nurserymen.

G. Container plant inspection and rejection: root condition of container plants will be determined by the Architect through the removal of plant from the container of at least

two plants but not more than 2 percent of the total number each species from each source.

H. Landscape Architect will inspect trees and shrubs upon delivery. Trees and shrubs will be rejected for the following characteristics:
   1. Enlarged cankers or galls at the base of the trunk, just above the soil level.
   2. Crooked trunks
   3. Scars or trunk damage, broken branches, etc.
   4. Asymmetrical branching
   5. Rootbound condition
   6. Trees that have been recently pruned
   7. Trees not matching in size and shape of the representative photograph sample

I. Quantities: Quantities of plant material shall be furnished as needed to complete work as indicated on the drawings, including reseeding, replanting, and maintenance (replacements) during the contract period. Quantities shown on the drawings are for reference only, the contractor is responsible for verifying all plant counts.

J. Sizes and Caliper: Minimum height (above soil level), width (average diameter of dripline), and caliper (trees only, measured at 30 inches above the soil level) of plant materials shall be as shown in expanded plant materials legend on planting detail sheet.

2.2 TREE STAKES

A. Tree stakes shall be a minimum 2 inches in diameter by 10 feet long new treated lodge pole pine.

2.3 TREES AND VINE TIES

A. Tree ties shall be "Cinch-Tie" as manufactured by V.I.T. Products, Escondido, CA (619) 480-6702, or approved equal.

B. 1 1/2-inch galvanized roofing nails to secure ties.

2.4 TREE GUYING MATERIAL

A. Anchors shall be Duckbill, Earth Anchor Systems, as manufactured by Forsight Products, Inc., or approved equal. Cable shall be non-coated, stainless steel braided cable, sized per manufacturer's recommendations.

B. Anchor and cable sizing shall be per the following schedule:

C. | Tree Caliper | Anchor | Cable size | Rated Capacity |
D. | Up to 3 inches | #40 | 1/16 inch | 300 pounds |
E. | 3 inches to 6 inches | #68 | 1/8 inch | 1,100 pounds |
F. | 6 inches to 11inches | #88 | 3/16 inch | 3,000 pounds |

G. Hose cable guards shall be new 5/8-inch rubber, brown or red.

H. Cable sleeves shall be new 1/2-inch white Schedule 40 PVC pipe.

I. Cable clamps shall be hot dip galvanized. Swedge fittings are not allowed, except at anchor.

2.5 BACKFILL AMENDMENTS

A. Refer to Section 32 91 13 for specification of soil amendments and conditions.

2.6 IMPORT SOIL OR TOPSOIL

A. Refer to Section 32 91 13 for specification.

2.7 PLANT PIT BACKFILL MATERIAL

A. Backfill material for plant pits shall be a mixture as noted below or as indicated on drawings. The materials shall be thoroughly batch-mixed prior to placement so that they

are evenly distributed and without clods or lumps. Backfill shall be so placed in the pits that the plant will be at its natural growing height after settlement. The following amendments and quantities shall be used as the basis for bids.

| | |
|---|---|
| 50 percent by volume | Excavated soil, free from rocks, etc. |
| 50 percent by volume | Organic soil Amendment |
| 5 pounds | Agricultural gypsum per cu. yd. of mix |
| 8 pounds | Humate Plus per cu. yd. of mix |
| 2 pounds | Granular Fertilizer per cu. yd. of mix |

2.8 ORGANIC MULCH MATERIAL

A. Pre-approved mulch: Dark Hemlock Bark, available from High Desert Mulching, Bend, OR (541) 330-5558; or approved equal meeting the following requirements:
   1. Wood chip mulch shall consist of 100 percent recycled above ground tree products. Mulch shall be nitrogen stabilized and shall contain no trash, hazardous waste, or toxic materials.
   2. Mulch shall be ground and screened to 2-inch minus particle size.

2.9 PRE-EMERGENT HERBICIDE

A. Pre-emergent herbicides shall be wettable powder or granular type.
B. Select pre-emergent herbicide appropriate to site area, soil type, indigenous weeds to be controlled, and type of ground cover to be planted.
C. Follow manufacturer's precautions and label instructions. Comply with local jurisdictional restrictions and ordinances.

2.10 FERTILIZER TABLETS

A. Tablets shall be "Agriform" as manufactured by Sierra Industries.
B. Agriform 21-gram tablets.
C. Agriform 5-gram tablets.

2.11 MYCORRHIZAL INOCULUM

A. Shall be “Mycoapply” All Purpose Granular by Mycoorrhizal Applications Inc., Grants Pass, OR p541.476.3985

**PART 3 - EXECUTION**

3.1 GENERAL

A. Planting operations shall not commence until completion of construction work, grading, soil preparation, weed control, and sprinkler installation.
B. Irrigation system shall be fully operational including automatic controller, before commencing planting operations.

3.2 SPACING OF PLANT MATERIAL

A. When plant materials are shown in rows, the total length of the area shall be verified, and the plants equally spaced within the area. When plant materials are shown in a random pattern, the material shall be equally spaced and placed to fill the area. Ground cover material shall be triangular or square spacing as indicated on the Drawings. When spacing is not shown, use triangular spacing.

B. Trees and specimen shrubs shall be located with a wood stake or flag. The locations shall be reviewed and accepted by the Architect prior to planting.

C. The work shown on the Drawings is schematic with trees, shrubs and groundcovers shown in their approximate locations. Contractor shall not locate any items where it is obvious that they are in direct permanent improvements, or pedestrian and vehicular safety considerations. Contractor shall not install plant materials in locations where the ultimate growth of the plant materials will damage or affect structures or impede pedestrian or vehicular circulation. Do not locate trees or taller shrubs in locations where they will block irrigation heads and prevent adequate coverage. Where called for, obtain approval of the landscape architect for placement of trees, shrubs, and other items of work.

D. Locate trees and taller shrubs 10 feet minimum away from rotor irrigation heads, 5 feet minimum from spray heads.

3.3 PLANT PITS AND PLANTING

A. Plant pits shall be dug with level bottoms to widths and depths as shown on the Drawings. Pits for trees shall be dug square. Fill pits with water and allow to drain. All tree pits must meet the drainage requirement set forth in Section 32 91 13, Part 3.03, whether the area of the tree planting was tested for percolation or not. Notify Architect of any tree pit that does not meet the percolation test standard.

B. Plant holes dug by auger method will be acceptable but shall have side walls roughened or squared with a shovel. Slick pit walls caused by auguring in too wet soil will not be accepted for planting.

C. Handling: no canned plant material shall be planted if the ball is broken or cracked either before or during the process of planting.

D. Setting: plants shall be set with top of root ball 1 inch above finish grade. Each plant shall be placed in center of plant pit.

E. Pit Backfilling

1. Build mound of compacted backfill wide enough in bottom of hole to support root ball.
2. Backfill pit with backfill mix half-way to finish grade and water thoroughly.
3. Place 21-gram plant tablets in plant pits, adhering to the following plant size schedule:
    - 1 Gallon: 1 tablet
    - 3 Gallon: 1 tablet
    - 5 Gallon: 2 tablets
    - 1 ½ inch Cal.: 4 tablets
    - 2-inch Cal.: 6 tablets
    - 3 inch Cal.: 8 tablets
4. Backfill to finish grade. Backfill mix shall be tamped lightly, and a shallow basin formed at perimeter of root ball to hold enough water to saturate the root ball and backfill mix.
5. Water immediately to saturate entire root ball and backfill.
6. Remove watering basin prior to hydroseeding (in turf areas only).
7. Apply Granular Mycorrhizal Inoculum per manufacturers instruction, at the following schedule:
    - Liner / 4” pot: 1-2ml
    - 1 gallon: 1tsp
    - 5 gallon: 1tbs.
    - 1 ½ inch Cal.: ½ cup
    - 2-inch Cal.: 1 cup

- 3-inch Cal: 1 1/2 cups

3.4 TREE STAKING

A. Stake trees as shown in details.
B. Tree and stakes shall be vertical and plumb in cases.
C. One-gallon trees shall be planted with nursery stakes removed.

3.5 FLATTED GROUND COVER

A. Rooted cuttings shall be planted sufficiently deep to cover roots and spaced as specified in ground cover list on landscape plan.
B. Rooted cuttings shall not be allowed to dry out before or while being planted. Wilted plants shall not be accepted.
C. At time of planting ground cover plants, the earth around each plant shall be firmed sufficiently to force out air pockets.
D. Each ground cover plant shall be planted with a minimum of one (1) 5-gram 20-15-5 plant tablet adjacent to root zone.

3.6 APPLICATION OF PRE-EMERGENT HERBICIDE

A. Apply pre-emergent herbicide to shrub and planted groundcover areas only. Do not apply to hydroseeded areas. Strictly adhere to manufacturer's specifications for application rates and methods.
B. Apply pre-emergent only after planting operations have been completed so as to minimize disturbance of the chemical "barrier." Reapply where necessary to areas disturbed by planting or repair operations after initial application.
C. Pay careful attention to activation requirements, "watering-in", etc., per manufacturer's specifications and label instructions. Avoid excessive irrigation run-off that would move or wash away the pre-emergent "barrier" -- use repeat watering cycles and split watering times.

3.7 MULCHING

A. After, planting operations are complete and shrubs areas have been raked and dressed, mulch shrubs and ground cover areas with a 2-inch layer of organic mulch material.
B. Mulch layer should taper to zero at plant stem or tree trunk. Do not place mulch materials up against plant crown or trunk.
C. Mulch flatted ground cover areas prior to planting ground cover, if called for on the drawings.

3.8 PROTECTION

A. The Contractor shall carefully and continuously protect areas included in the contract, including lawn areas, plant material, supports, etc. until final acceptance of the work by the Owner or his representative.

3.9 CLEAN-UP

A. After planting operations are completed, Contractor shall remove trash, excess soil, empty plant containers, or other accumulated debris from the site at no extra cost to Owner. Contractor shall repair scars, ruts, or mars in area caused by work operations. Areas shall be left in a neat and orderly condition.

3.10 OBSERVATIONS

A. Contractor shall give forty-eight (48) hours notice and set appointment for reviews by the Architect.
B. Review by Architect shall be scheduled for the following operations:

1. Review of plant material after delivery to the site.
2. Tree and shrubs placement prior to digging holes.
3. Review of ground cover lines and header board prior to planting.
4. Start of establishment period/acceptance of installation.

C. Reviews shall be called for at the end of planting operations for the purpose of determining compliance with drawings and specifications, intent, workmanship, and clean-up. Contractor shall secure written verification of review data, any corrections required to work, and limits of reviewed area before beginning the described establishment work.

D. In the event the Contractor requests inspection of work, and said work is substantially incomplete, the Contractor shall be responsible for Architect's hourly charges and per diem costs.

3.11 GUARANTEE

A. Shrubs and ground covers shall be guaranteed as to growth and health for a period of 90 days after final acceptance by the Owner or his representative; 15 gallon and box sized trees shall be guaranteed for a period of 1 year after date of substantial completion.

B. Plants installed in the fall (after October 1st) will shall be guaranteed to survive the winter and will be evaluated in the spring.

C. Plants which die or lose more than 30 percent of their original leaves shall be replaced under this section.

D. The Contractor, within 14 days of written notification by the Owner, shall remove and replace guaranteed plant materials which for any reason fail to meet the requirements of the guarantee. Plants material replaced shall be guaranteed for the original period, starting from the date of replacement.

END OF SECTION 329300

**SECTION 33 3100 - SANITARY SEWERAGE PIPING**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sanitary sewerage piping.
2. Bedding and cover materials.

B. Related Requirements:

1. Section 31 0513 - Soils for Earthwork.
2. Section 31 0516 - Aggregates for Earthwork.
3. Section 31 2316 - Excavation.
4. Section 31 2317 - Trenching.
5. Section 31 2323 - Fill.
6. Section 33 0561 - Concrete Manholes.

1.2 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Water Works Association:

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
7. AWWA C153 - Ductile-Iron Compact Fittings.

C. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
2. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
5. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
6. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
7. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
9. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
10. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
11. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
12. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
13. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
14. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
15. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
16. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
17. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

D. International Association of Plumbing and Mechanical Officials (IAPMO):

1. Current Oregon Plumbing Specialty Code (OPSC).

## 1.4 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information indicating pipe material to be used, pipe accessories, fittings, and cleanouts.

C. Manufacturer’s Installation Instructions: Indicate special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Qualifications Statement:

1. Submit qualifications for manufacturer and installer.

## 1.5 CLOSEOUT SUBMITTALS

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record finished locations of pipe runs, connections, manholes, cleanouts, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

## 1.6 QUALITY ASSURANCE

A. Perform Work according to Section 00445 of the Oregon Standard Specifications for Construction as modified by the current Deschutes County Standards and Specifications.

B. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage systems per the Oregon Plumbing Specialty Code (OPSC), the Oregon Health Division, and the Oregon Department of Environmental Quality (DEQ).

C. Utility Compliance: Comply with the governing agency regulations pertaining to sanitary sewerage.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 6000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:

1. Store materials according to manufacturer instructions.
2. Store valves in shipping containers with labeling in place.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Provide additional protection according to manufacturer instructions.

## 1.8 EXISTING CONDITIONS

A. Indicated locations of existing utilities and structures are approximate. Call for underground utility locates and verify existing utility locations before commencing work. Locate existing piping and structures to be closed and/or abandoned.

B. Traffic Control: 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 the governing agency.
2. Provide alternate routes around closed or obstructed pedestrian and traffic ways, as required by the governing agency, including temporary ADA accessibility.

C. Field Measurements:

1. Verify field measurements with Plans prior to fabrication and ordering.
2. Indicate field measurements on Shop Drawings.

D. Site Information: Reports on subsurface condition investigations made during the design of the Project are provided for informational purposes only; data in reports are not intended as representations or warranties of accuracy or continuity of conditions (between test pits). Owner's Representative assumes no responsibility for interpretations or conclusions drawn from this information.

E. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer distribution service according to requirements indicated:

1. Notify Owner's Representative of governing agency no fewer than 48 hours in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer service without Owner's Representative written permission.

1.9 COORDINATION

A. Section 01 3000 – Administrative Requirements: Coordination and project conditions.

B. Coordinate the Work with termination of sanitary sewer connection outside building, connection to public facilities.

PART 2 - PRODUCTS

2.1 SANITARY SEWERAGE PIPING

A. Plastic Pipe:

1. Material: PVC.
2. Comply with ASTM D3034, SDR-35 (Minimum), Poly Vinyl Chloride (PVC) material.
3. Inside Nominal Diameter: As indicated on Drawings
4. End Connections: Bell and spigot with rubber-ring-sealed gasket joint.
5. Fittings: ASTM D3034, SDR-35 PVC.
6. Joints:

a. Elastomeric gaskets.
b. Comply with ASTM F477.

7. Primer, Solvents, Cement, and Gaskets for PVC Pipe and Fittings:

a. Primer: ASTM F656
b. Solvent Cement: ASTM D2564
c. Gaskets: ASTM F 477, elastomeric seal

2.2 MANHOLES

A. As specified in Section 33 0561 – Concrete Manholes.

2.3 CLEANOUTS

A. Cleanouts shall be in accordance with the Plans and Uniform Plumbing Code requirements. Where not indicated, the following requirements shall apply. Shop drawings shall be submitted to the Engineer for approval prior to installation.

B. Cast Iron Cleanouts:

1. Description: ASME A112.36.2M, round, cast-iron housing with clamping device and round, secured, scoriated cast iron cover. Include cast-iron ferrule with inside chalk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Cleanouts in Vehicle-Traffic Service Areas: Use Heavy-Duty, top-loading classification cleanouts.
3. Cleanouts in Earthen Areas: Use Medium-Duty, top-loading classification cleanouts.
4. Storm Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

C. PVC Cleanouts:

1. Riser Pipe and Fittings: Riser pipe and fittings of same material as storm drainage piping.
2. Frame and Cover: Part No. M-1018 by Olympic Foundry or Engineer-approved equal.
3. Plug: PVC thread plug.

2.4 MATERIALS

A. Bedding and Cover:

1. Bedding: Base Aggregate as specified in Section 31 0516.
2. Cover: Base Aggregate as specified in Section 31 0516.
3. Soil Backfill from Above Pipe to Finish Grade: Per Section 31 2317 - Trenching

2.5 ACCESSORIES

A. Pipe Markers: Furnish in accordance with Section 00445 of the Oregon Standard Specifications for Construction as modified by the current Deschutes County Standards and Specifications.

1. Plastic Ribbon Tape: Bright colored (green), continuously printed, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.
2. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with “Sewer Service” in large letters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 3000 – Administrative Requirements: Verification of existing conditions before starting work.

B. Verify site subgrade is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation with coarse aggregate.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with franchise utilities to eliminate interference.
3. Notify Architect/Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 2317 – Trenching.
2. Hand trim excavation for accurate placement of piping to indicated elevations.
3. Place bedding material at trench bottom.
4. Level materials in continuous layer not exceeding 6 inches.
5. Maintain optimum moisture content of bedding material to attain required compaction density.
6. Level fill materials in continuous layers not exceeding 6 inches in depth, and compact to 95 percent maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to the current Oregon Plumbing Specialty Code and Section 00445 of the Oregon Standard Specifications for Construction as modified by the current Deschutes County Standards and Specifications.
2. Lay pipe to slope gradients as indicated on Drawings.
3. Begin at downstream end of system and progress upstream.
4. Bedding: As indicated on Drawings.
5. Lay bell-and-spigot pipe with bells upstream.
6. Backfill and compact as specified in Section 31 2317 - Trenching.
7. Do not displace or damage pipe when compacting.
8. Connect to building sanitary sewer outlet and municipal sewer system.

9. Pipe Markers: Use Plastic Ribbon Tape over ferrous piping. Use Plastic Ribbon Tape and Tracer Wire over nonferrous piping and over edges of underground structures. Extend Plastic Ribbon Tape and Tracer Wire into manholes.
10. Install Site sanitary sewage system piping to within 5 feet of building, and connect to building sanitary waste system.

C. Cleanouts:

1. Cleanouts shall be provided where indicated on the Plans, and shall be installed in accordance with OPSC requirements. Where not indicated, the following requirements shall apply.
2. Install cleanouts and riser extensions from storm pipes to cleanouts at grade. Use cast-iron soil pipe fittings in storm pipe at branches for cleanouts, and use PVC or cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in storm pipe.

D. Connections

1. Connections shall be provided where indicated on the Plans, and shall be installed in accordance with these Specifications. Where not indicated, the following requirements shall apply.
2. Connect non-pressure, gravity flow drainage piping to building sanitary sewer drains per these Specifications. Terminate piping where indicated.
3. Make connections to existing piping and underground structures so finished work conforms as nearly as practical to requirements specified for new work, and as follows:

    a. Finished work shall conform as nearly as practical to requirements specified for new work.
    b. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping.
    c. Make branch connections from side into existing piping NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing pipe.
    d. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting opening into existing unit large enough to allow 3 inches of non-shrink grout to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection with 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
    e. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated, in accordance with Section 30 3000 – Cast-In-Place Concrete.
    f. Use epoxy-bonding compound, in accordance with Section 30 3000 – Cast-In-Place Concrete at interface between new and existing concrete and piping materials.
    g. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.

4. Connect to grease, oil, sediment, or sand interceptors as required, per these Specifications.
5. Pipe couplings, expansion joints, and deflection fittings with pressure ratings of at least equal to piping rating shall be used in applications unless otherwise indicated below.
    a. Use non-pressure type flexible couplings where indicated to join gravity-flow, non-pressure drainage piping unless otherwise indicated.

b. Unshielded flexible couplings for same or minor difference OD pipes.
c. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different ID.
d. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

6. System Piping Joints: Make joints using system manufacturer's couplings, except where otherwise specified.
7. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and fit both systems' materials and dimensions.

E. Manholes: As specified in Section 33 0561 – Concrete Manholes.

F. Backfilling: As specified in Section 31 2323 - Fill.

## 3.4 FIELD QUALITY CONTROL

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Testing:

1. Perform test on site sanitary sewage system in accordance with Section 00445 of the Oregon Standard Specifications for Construction as modified by the Deschutes County Standards and Specifications.
2. Leaks and loss in pressure constitute defects that must be repaired.
3. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified

## 3.5 PROTECTION

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

C. Cap open ends of piping during periods of Work stoppage.

**END OF SECTION 33 3100**

# SECTION 334200

# STORMWATER AND LEACHATE SYSTEMS

## PART I – GENERAL

### 1.1 SUMMARY

A. Section includes construction of stormwater management system as shown on the Drawings.

B. Related Sections:

1. Project Site/Civil Technical Specifications
2. Misc. Specification: Oil/Water Separator
3. Misc. Specification: Contech Slotted Drains and Hel-Core Pipe

### 1.2 REFERENCES

A. American Association of State and Highway Transportation Officials (AASHTO)

1. AASHTO M170, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
2. AASHTO M278, Standard Specification for Class PS46 Poly(Vinyl Chloride) (PVC) Pipe
3. AASHTO M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.
4. AASHTO M294, Standard Specification for Corrugated Polyethylene Pipe, 12- to 36-in Diameter.

B. American Society for Testing and Materials (ASTM):

1. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 kN-m/m$^3$)).
2. ASTM D1056, Standard Specification for Flexible Cellular Materials- Sponge or Expanded Rubber.
3. ASTM D1784-03, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
4. ASTM D4396, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
5. ASTM D4396-15, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Nonpressure Applications.
6. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
7. ASTM F714, Standard Specification for Polyethylene (PE) plastic Pipe (DR-PB) Based on Outside Diameter.
8. ASTM F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

C. Project Stormwater Pollution Prevention Plan (SWPPP).

## 1.3 SUBMITTALS

A. Omitted.

B. Submit certificates of conformance with specifications, and product data, for the materials specified within this Section.

## 1.4 DELIVERY, STORAGE AND HANDLING

A. During loading, transporting, and unloading, exercise care to prevent damage to materials.

B. All materials shall be inspected by the Contractor upon delivery to the site. The Contractor shall notify the CQA ENGINEER of any loss or damage. Damaged or defective materials shall be rejected and shall be replaced with new materials at the supplier's or Contractor's expense.

# PART 2 PRODUCTS

## 2.1 POLYVINYL CHLORIDE PIPE INSTALLATION

A. Piping and fittings for the stormwater system shall be made of polyvinyl chloride (PVC) in compliance with ASTM D1784 unless otherwise stated in the Drawings. 6 inch to 12 inch diameter pipes shall be AWWA C900 DR 25 and pipes larger than 12 inches shall conform to AWWA C905 DR 25 specifications.

B. Pipe shall be manufactured in accordance with AASHTO M278, for 4-inch through 15-inch diameter.

# PART 3 EXECUTION

## 3.1 PIPE INSTALLATION

A. Excavate and grade trenches for piping to the width, depth, grade, and alignment shown on the Drawings, and as specified in Project Site/Civil Technical Specifications.

B. Grade the bottom of the trench to provide a firm bedding surface of uniform density along the entire length of the pipe.

C. Shape the bottom of the trench as specified in the detailed Drawings for pipe installation

D. Install pipe bedding material as described in Project Site/Civil Technical Specifications and as shown on the Drawings.

E. Install pipe as shown on the Drawings and described herein.

1. Lay each section of the pipe in the pipe trench.
2. Pipe shall be joined together as per the manufacturer’s recommendations.

F. Backfill and compact trench backfill as shown on the Drawings and as specified in Project Site/Civil Technical Specifications.

## 3.2 DITCHES

A. Cut accurately to the cross sections, grades, and elevations shown on the Drawings.

B. Maintain excavation from detrimental quantities of debris until completion of work.

C. Place excavated materials as shown on the Drawings or as directed by the Owner's Representative; except do not, in any case, deposit materials less than three feet from the edge of a ditch.

END OF SECTION

# PROJECT SITE/CIVIL TECHNICAL SPECIFICATIONS

## 1. GENERAL NOTES

### A. DEFINITIONS

(1) Whenever in these Project Site/Civil Technical Specifications the following terms are used, the intent and meaning shall be interpreted as follows:

(a) Governing Agency: Government or regulatory entity with authority to implement and enforce specific laws, permit requirements, or construction requirements.

(b) Owner: Entity or individual for whom the project is being performed.

(c) Contractor: Entity or individual responsible for performing construction activities and furnishing all labor, materials, equipment and other incidental work necessary for the successful completion of the project and for carrying out all duties and obligations imposed by the contract.

(d) Engineer: Licensed professional engineering entity, or licensed professional engineer and/or authorized agent(s), who represents the Owner during the construction phase of the project work.

(e) Geotechnical Engineer: Licensed professional engineering entity, or licensed professional engineer and/or authorized agent(s), who, in representing the Owner, is involved with the principles, properties and behavior of earth materials with regard to the project work.

(f) Project Drawings / Plans: The drawings that define the required site development activities and improvements.

(g) ODOT Standard Specifications: The current edition of the Oregon Department of Transportation's (ODOT) "Standard Specifications For Construction" including all applicable current supplemental specifications and special provisions.

### B. GOVERNING REGULATIONS

(1) All project activities and improvements shall be in accordance with the Governing Agency regulations. In the event of conflict with these Project Site/Civil Technical Specifications, or the indicated Reference Specifications, the Governing Agency regulations shall apply.

### C. REFERENCE STANDARDS AND SPECIFICATIONS

(1) Site development activities and improvements, including site preparation and demolition, earthwork, sanitary sewers, storm drainage, water supply, pavement, lighting, landscape improvements, and erosion/sediment control measures shall be in accordance with the Reference Specifications indicated throughout these Project Site/Civil Technical Specifications. All Reference Specifications shall be incorporated into and made a part of the Project Site/Civil Technical Specifications. When the Reference Specifications conflict with Project Site/Civil Technical Specifications, Project Site/Civil Technical Specifications shall govern.

### D. CONTRACT GENERAL CONDITIONS

(1) These Project Site/Civil Technical Specifications supplement the engineering plans, the Agreement between Owner and Contractor, and other supplemental documents that comprise the overall project Contract. These Project Site/Civil Technical Specifications address the technical requirements of the project design as indicated on the Project Drawings (Plans). Unless specifically addressed in the Plans or these Project Site/Civil Technical Specifications, general conditions such as bid items, quantities, unit prices, terms

of payment, change management, construction schedule, submittals, and other conditions are defined in the Agreement between Owner and Contractor.

(2) The Contractor shall be responsible for complying with applicable Federal, State, and local requirements, together with exercising precaution at all times for the protection of persons (including employees) and property. It is the sole responsibility of the contractor to initiate, maintain, and supervise all safety requirements, precautions, and programs in connection with the work.

(3) The Contractor shall indemnify and hold harmless the Owner and Engineer for any and all injuries and/or damages to personnel, equipment, and/or existing facilities occurring in the course of the site improvement construction work described in the Plans and these Project Site/Civil Technical Specifications.

(4) The Contractor shall obtain all required construction permits in accordance with local, state, and federal regulations.

(5) The Contractor shall guarantee all materials and workmanship for a period of 1 year following final acceptable by the Owner and the Governing Agencies.

E. QUALITY CONTROL OF MATERIALS

(1) Materials shall be inspected, sampled, and tested before, during, and after they are incorporated into the work. The timing of these activities shall be as appropriate for the materials being placed and the properties (composition, gradation, density, strength, compaction, etc.) being examined. The requirements for quality testing are specified within the applicable sections of these Project Site/Civil Technical Specifications.

(2) Materials not conforming to the requirements of the Project Site/Civil Technical Specifications at the time they are used or installed will be considered unacceptable and shall be removed and replaced with acceptable materials properly installed in place at the Contractor's expense.

(3) When material test results are not within specification tolerances, the supplier shall make appropriate adjustments at its source to correct the issue.

(4) Material inspections, sampling, and testing shall be performed by an independent testing agency/laboratory with suitable capabilities and experience. The testing entity shall be retained by Contractor or Owner, as required or as specified in the Contract Documents.

## 2. EXISTING CONDITIONS & SITE PREPARATION

A. EXISTING CONDITIONS

(1) Existing conditions as depicted on the Plans are general and illustrative in nature. It is the responsibility of the Contractor to examine the site and be familiar with existing conditions prior to initiating construction. If conditions are encountered, before or during construction, that are significantly different than those shown on the Plans, Contractor shall notify the Engineer immediately.

(2) It is not the Engineer's intent that any single plan sheet in the Plans fully depicts all work associated with the project. The Contractor shall be familiar with all sheets in the Plans for construction. Contractor shall similarly be familiar with all structural, architectural, mechanical, electrical, or other plans, as necessary, for the construction of the overall project.

(3) Contractor shall protect all property corner pins, permanent monuments, and permanent benchmarks during construction. If disturbed, Contractor shall have items reset by a licenses surveyor at Contractor expense.

(4) Contractor shall protect all existing utilities, structures, and features to remain. Any items to remain that have been disturbed or damaged as a result of construction shall be repaired or replaced at Contractor expense.

B. EXISTING UTILITIES

(1) Underground utility information shown on the Plans may be based upon a combination of topographic survey data, field observations, historical utility maps, Owner-provided information, or other available data for the Site. The Plans constitute a representation of utility locations from best-known information available to the Engineer. There is no guarantee that the utilities shown comprise all such utilities in the area, either in service, or abandoned.

(2) Contractor shall be responsible for contacting all agencies, utility companies, and pipeline companies known or suspected to have buried cable, duct, sewer, pipes, etc., which may conflict with the project improvements to determine the location and depth of the existing utilities.

(3) If conflicts occur after the existing utility conditions have been determined by field investigations, Contractor shall immediately notify Engineer and either:

(a) Adjust the location and depth of the proposed improvements as directed by Engineer in cooperation with the Owner, or

(b) If relocation of proposed improvements is not feasible, Contractor shall work with Owner and Engineer to make arrangements with the affected utility companies to have their utilities protected or relocated.

(4) All utility disconnection, removal, relocation, cutting, capping, and/or abandonment shall be coordinate with the appropriate utility company / agency.

C. EROSION / SEDIMENTATION CONTROL

(1) Erosion/sedimentation control measures, as indicated on the Plans and as required elsewhere in these Project Site/Civil Technical Specifications, shall be employed during the course of construction operations and until suitable ground covers are established on all construction site areas.

(2) Erosion/sedimentation control measures shall be properly installed and functional prior to any earth disturbing activities.

D. CONSTRUCTION ACCESS

(1) Construction ingress-egress shall be limited to defined connections to adjacent driveways and public roadways, and as indicated on the plans and as required elsewhere in these Project Site/Civil Technical Specifications.

E. TRAFFIC CONTROL

(1) The Contractor shall provide necessary traffic control for work performed in active transportation areas, including any specific traffic control requirements as indicated on the Plans.

F. TREE AND LANDSCAPE PROTECTION

Tree and landscape protection, if required, shall be as defined by the landscaping designer.

G. MATERIAL DISPOSAL

(1) All demolition waste and construction debris shall become the property of the Contractor unless otherwise stated in the Agreement between Owner and Contractor.

(2) The following shall be removed from the construction site and properly disposed of in a legal manner. Unless otherwise stated in the Agreement between Owner and Contractor, the cost of removal and disposal shall be included in the fixed or unit prices for the various contract pay items and no additional payment will be allowed therefor.

(a) All surplus excavated materials.

(b) Construction and demolition debris such as building materials, asphalt and concrete pavement materials, culvert and sewer pipe, utility and drainage structures, retaining walls (concrete, stone and timber), trees, shrubs, and miscellaneous landscape features removed during the installation of the project improvements.

(3) If Contractor intends to dispose of generated construction / demolition debris materials or excavated soils at a regulated clean construction / demolition debris or uncontaminated soil fill operation, the contractor shall be responsible for taking all actions and preparing all documents required by Oregon Administrative Rules prior to transport of the materials / soil to the disposal facility. Materials and soils that do not meet clean construction / demolition debris and uncontaminated soil constituent limit requirements shall be disposed of at a permitted landfill facility. The cost of testing and documentation to evaluate the materials / soils and determine proper disposal requirements shall be as defined in the Agreement between Owner and Contractor.

(4) See Earthwork Operations specification section for additional requirements.

H. SITE SECURITY FENCING

(1) Shall be provided in accordance with Project Plans.

3. EARTHWORK OPERATIONS

A. GENERAL

(1) Except where modified by the following Project Site/Civil Technical Specifications, all earthwork operation and compaction requirements shall be in conformance with the material, installation and testing requirements of the ODOT Standard Specifications.

(2) Earthwork shall include site clearing, tree and hedge removal, topsoil and rootmat stripping and stockpiling, earth and fill material excavation, construction of embankments and slopes, placement and compaction of non-structural fill areas, pavement areas, and structural fill areas, removal and disposal of surplus and unsuitable excavated materials, topsoil placement, and final shaping and trimming to the lines and grades indicated on the Plans.

(3) Prior to commencement of earthwork operations, Contractor shall notify any Utility Protection Service or other Governing Agency, as may be required.

B. SITE CLEARING

(1) All construction site features and items such as structures, foundations, fences, pavements, rubbish/debris, trees, shrubs, and surface vegetation shall be removed where necessary and as indicated on the Plans for the construction of the project improvements.

(2) No tree, shrub, or surface vegetation shall be removed unless it is marked for removal or the Engineer specifically authorizes its removal.

(3) When indicated on the Plans, brush, shrubs, branches and small trees shall be shredded or chipped using suitable mechanical equipment. The resulting material shall be stockpiled on-site, as directed by the Engineer, for the Owners' future use. Tree trunks, branches, and removed stumps too large to be chipped shall be removed from the site and disposed of.

(4) Tree stumps shall be removed by excavation or grinding to a depth of not less than 12 inches below ground surface. Material resulting from stump grinding shall be spread on the ground and excavated as part of topsoil or rootmat stripping.

(5) All items and materials not specifically required to remain on-site shall be removed from the site and disposed of in a legal manner.

C. TOPSOIL AND ROOTMAT REMOVAL

(1) Existing topsoil shall be removed from proposed pavement and building areas, non-structural fill areas, and structural fill areas. Sufficient existing topsoil shall be stockpiled

for future use as topsoil replacement. Excess topsoil shall be removed from the Site and disposed in a legal manner. Additional topsoil requirements are as dictated by the landscape designer.

(2) Contractor shall review available soil borings or geotechnical report to determine existing estimated topsoil thickness in the areas where explored. Topsoil thickness may vary across the site and can only be verified by a Geotechnical Engineer.

(3) Topsoil volumes, if estimated as part of this project, assume that a minimum of 8 inches of topsoil and 4 inches of underlying soil will be stripped as described in C (1), unless otherwise specified on the project plans. The actual volume to be stripped will be based on equipment used and the Contractor's means and methods. CEC and the Owner are not responsible for the Contractor's choice of equipment or their interpretation of topsoil thickness and resulting increased volumes.

(4) If existing topsoil is found to be greater than 12 inches thick, the Geotechnical Engineer shall be contacted prior to removal of the topsoil to verify the thickness and extents. No additional costs will be paid to the Contractor for an increase in the volume of topsoil stripped and stockpiled unless approved by the Engineer.

(5) When approved by Geotechnical Engineer, stripped topsoil may be used as non-structural fill to design elevations. Topsoil not used for replacement or for non-structural fill shall be removed from the site and legally disposed of, unless directed by Owner to stockpile on-site for future use. Stockpile locations shall be as authorized by Owner.

(6) Topsoil supplied from off-site sources shall be natural, fertile agricultural soil material capable of sustaining vigorous plant growth. It shall contain not less than 4% nor more than 10% organic matter, as determined in accordance with AASHTO T194. It shall contain not less than 12% nor more than 50% clay and the sand content shall not exceed 55%, both as determined in accordance with AASHTO T88. The pH shall be between 5.0 and 8.0. Topsoil material shall be relatively free from large roots, sticks, weeds, brush, stones larger than 1-inch in diameter, or other litter or waste products. It shall be a loamy mixture having at least 90% passing the No. 10 sieve.

(7) Within proposed pavement and building areas where there is no existing topsoil, the surface layer of organic material (friable soil containing roots or other vegetative matter) shall be removed before starting fill and compaction operations. Such removed material may be used as non-structural fill. If this material is not used as non-structural fill, it shall be removed from the site and disposed in a legal manner.

D. EXCAVATION

(1) Existing earth and fill materials within the project construction limits shall be excavated as necessary to establish the elevations, contours, and drainage patterns indicated on the Plans. Excavated materials classified by Geotechnical Engineer as suitable structural fill material shall be used to construct compacted subgrades within the project building and pavement areas. Excess materials not needed for filling or for the construction of berms or embankments shall be removed from the site and legally disposed of, unless directed by the Engineer or Owner to stockpile on-site for future use. Stockpile locations shall be as authorized by the Owner.

(2) Rock materials within the project construction limits shall be excavated to a minimum of 6 inches below subgrade levels of proposed pavements and pipe bedding. Rock materials shall be removed to a minimum of 18 inches below building and structure foundations. Rock materials shall be defined as boulders one cubic yard or greater in volume and all materials in ledges, bedded deposits, and conglomerate deposits that exhibit the physical characteristics of rock, as determined by Geotechnical Engineer. Excavated rock materials not used for filling or for the construction of berms or embankments shall be removed from

the site and disposed of, unless directed by the Engineer or Owner to stockpile on-site for future use. Stockpile locations shall be as authorized by the Owner.

(3) Per the project geotechnical report, competent basalt bedrock will require hydraulic-hammering or blasting to efficiently remove excess material. See geotechnical report for additional excavation/grading guidance. On-site native soil and rock should be suitable for re-use as structural fill with sufficient on-site processing, provided it meets the specifications provided in Table 6.1.2 of the geotechnical report.

(4) Excavated materials classified by the Geotechnical Engineer as unstable or unsuitable for structural fill purposes and not needed for non-structural fill, shall be removed from the site and legally disposed of, unless directed by the Engineer or Owner to stockpile on-site for future use. Stockpile locations shall be as authorized by the Owner.

(5) Excavations shall be maintained in a well-drained condition at all times. Temporary drainage (dewatering) facilities shall be provided where surface runoff is not possible or effective. Such facilities shall be operated during the entire course of earthwork operations. Dewatering facilities shall include appropriate erosion and sediment control measures, as indicated elsewhere in these Project Site/Civil Technical Specifications. Unless otherwise stated in the Agreement between Owner and Contractor, the cost of temporary drainage facilities and dewatering activities shall be considered incidental to the various pay items of the work.

E. FILL PLACEMENT

(1) Before placing any fill within pavement or structural areas, the existing subgrade shall be compacted as indicated in the "Compaction" section of these Project Site/Civil Technical Specifications. Pavement subgrade areas shall be proof-rolled to check for soft, unstable, or otherwise unsuitable materials and approved by a Geotechnical Engineer prior to paving operations. Where possible, proof-rolling shall be accomplished with at least four passes of a fully loaded tandem axle dump truck. Below-grade footing or foundation areas shall be inspected by a Geotechnical Engineer prior to foundation installation. Soft, unstable, or otherwise unsuitable materials shall be removed and replaced as directed by Geotechnical Engineer.

(2) Structural fill materials shall be soil materials that can be compacted to develop a stability satisfactory to the Geotechnical Engineer and in accordance with section 6.1.2 of the geotechnical report. Structural fill materials shall not contain frozen material or any material which, by decay or otherwise, might result in site or foundation settlement.

(3) Material Types For Structural Fill Purposes shall be as defined in the geotechnical report – see section 6.1.2 and table 6.1.2.

(4) Unsuitable Fill - Soil materials that are not in conformance with the stated criteria for structural fill material shall not be used as structural fill.

(5) Installed fill layers softened or otherwise damaged by rain, ponded water, or construction activities shall be scarified, dried, and recompacted, or removed and replaced. This work, even if performed after lift or fill acceptance, shall be incidental to the various pay items of the work.

(6) Unsuitable Subgrade Conditions:

(a) Within areas of new or reconstructed pavements, specific requirements for removal and remedial procedures shall be as directed by Geotechnical Engineer. Soft or otherwise unacceptable subgrade materials shall typically be removed to a depth where the minimum in situ unconfined compressive strength is 2.0 tsf and the in situ moisture content is no more than 3 percentage points above the optimum moisture content per ASTM D1557. When the depth of unsuitable material is excessive and does not warrant complete removal, remedial procedures will typically require partial removal of unsuitable subgrade material, placement of a geotextile fabric

(MIRAFI 600X or approved equal), and sufficient aggregate structural fill as defined by the geotechnical report and as directed by the Geotechnical Engineer. to the required subgrade level. Depths of unsuitable subgrade removal will be as directed by the Geotechnical Engineer. Alternative procedures may be required depending on the conditions encountered.

(b) Removal of unsuitable materials and installation of replacement fill material under and adjacent to proposed buildings and structures shall be as specified by Geotechnical Engineer.

(c) Payment for removal and replacement of unacceptable materials and the installation of geotextile fabric and aggregate fill shall be as indicated in the agreement between Owner and Contractor. Such payment shall include all work necessary for removal and disposal of unsuitable materials, supply and placement of fabric and aggregate materials, supply, placement and compaction of additional structural fill material, if required, and any dewatering required during these activities.

(7) Where necessary, structural fill materials shall be placed and compacted under proposed pavements, buildings, and structures. Compacted structural fill shall be placed to required subgrade elevations.

(8) Unsuitable materials may be placed within non-structural fill areas only where fill is required to obtain final subgrade levels and in accordance with the project geotechnical report. If borrow pits are used to obtain structural fill material, unsuitable materials may be used to bring the borrow areas to grade. Placement of such materials shall be limited to areas and depths authorized by the Geotechnical Engineer. If sufficient acceptable placement areas are not available, remaining unstable and unsuitable materials shall be removed from the site and legally disposed of.

(9) If necessary, Contractor shall provide sufficient suitable structural fill material from off-site sources as necessary to complete earthwork operations to the required levels and elevations indicated on the Plans. Structural fill materials shall be in conformance with the stated criteria for structural fill. Contractor shall provide the Geotechnical Engineer access to the proposed off-site sources to take samples and evaluate materials.

F. FILL COMPACTION

(1) Fill materials shall be placed in layers (lifts) and compacted in accordance with the geotechnical report – see table 6.1.2. Specific lift thickness and moisture content shall be as determined by the Geotechnical Engineer to obtain the required compaction and strength of material in place.

(2) Cohesive soils and well-graded aggregate mixtures shall be sampled and tested to determine the laboratory maximum density and optimum moisture content (control values) of the material in accordance with the geotechnical report.

(3) Free-draining cohesionless soils and aggregate mixtures shall be sampled and tested to determine the laboratory relative density (control value) of the material in accordance with the geotechnical report..

(4) Laboratory density and moisture tests shall be performed to determine the control values for each type and source of material to be used. One test of laboratory maximum density and optimum moisture content shall be performed for each 500 cubic yards of fill and backfill material, and when any change in material occurs that may affect the maximum density or optimum moisture content values.

(5) Aggregate supplier shall provide a written certification that the aggregate gradation and quality conforms to the project requirements. If a certification is not provided, gradation and quality tests shall be performed for each 500 cubic yards of stockpiled or in-place source material.

(6) Non-Structural Areas: Compact in accordance with the geotechnical report and as directed by the Geotechnical Engineer.
(7) Pavement Areas: Compact in accordance with the geotechnical report and as directed by the Geotechnical Engineer.
(8) Building Areas: Compact in accordance with the geotechnical report and as directed by the Geotechnical Engineer.
(9) Impervious Clay Liners (if required): Compact in accordance with the geotechnical report and as directed by the Geotechnical Engineer.
(10) Soil and aggregate fill materials compacted in place shall be field tested to determine in-place density and moisture values. A nuclear density gauge shall be used in accordance with ASTM D6938 to measure in-place density/moisture values of cohesive soils and well-graded aggregate materials, unless Geotechnical Engineer determines other testing equipment is more suitable for the type of material being tested. The dry unit weight of the in-place compacted material shall be compared to its control value to determine the percent compaction achieved.
(11) Frequency of fill material moisture content and compaction tests shall be as follows, unless otherwise adjusted by Geotechnical Engineer.
    (a) When using materials from exposed stockpile, excavation, or borrow area sources, a minimum of two moisture content tests per day shall be performed for each type and source of material being placed during stable weather. During unstable weather, moisture content tests shall be performed as determined by Geotechnical Engineer.
    (b) Within pavement areas, one in-place density test shall be performed for each 6,000 square feet, or fraction thereof, of each lift of material placed during each day.
    (c) Under building/structure ground slabs and mat foundations, one in-place density test shall be performed for each 3,000 square feet, or fraction thereof, of each lift of material placed during each day.
    (d) Under building/structure wall footings, one in-place density test shall be performed for each 100 lineal feet, or fraction thereof, of each lift of material placed during each day.
    (e) Under building/structure column footings, one in-place density test shall be performed for each footing, of each lift of material placed during each day.

G. MOISTURE CONTROL
(1) Where the subgrade, or other layer of soil, must be moisture-conditioned before compaction, the top 12 inches of the material shall be scarified or disked and then dried or moistened as required to achieve compaction. Water shall be applied uniformly in a manner that prevents free water from appearing on the surface during, or subsequent to, compaction operations. Material that is too wet to air dry and compact to the specified density shall be removed and replaced.

H. GRADING TOLERANCES
(1) Surface elevations shall be within the following indicated tolerances.
    (a) Under vehicle, pedestrian, and drainage control pavements, and building floor slabs: -0.08′ to +0.04′
    (b) Drainage swales and stormwater basins: -0.10′ to +0.10′
    (c) Embankments and slopes other than (b) above: -0.15′ to +0.15′
(2) Unless otherwise noted, grades and contours shown on the Plans are final topsoil and pavement surface elevations. All excavated and filled areas not within the limits of buildings, structures, or pavements shall be graded to 8 inches below the indicated elevations to allow for topsoil placement, unless otherwise indicated on the Landscaping Plans.

I. RESTORATION

(1) Previously prepared earth subgrade areas that are damaged by soil erosion or construction activities shall be repaired and graded to design contours and elevations before placement of pavement materials or topsoil.

(2) Areas not otherwise subject to disturbance that are damaged by movement or storage of construction vehicles, equipment, or materials, or other construction activities such as the discharge of water from the construction site, shall be restored to original conditions.

J. TOPSOIL PLACEMENT

(1) Topsoil shall be placed on all of the following areas. Minimum topsoil depth shall be 8 inches unless otherwise indicated on the Landscaping Plans. Topsoil placement shall include grading and shaping to required final contours and elevations.

(a) All project grass, landscape, or other vegetated areas indicated on the Landscaping Plans.

(b) All unpaved offsite areas damaged by installation of project associated utilities or pavements.

(c) All unpaved offsite areas disturbed by project-associated activities.

(2) If required or as indicated on the Landscaping Plans, Contractor shall obtain and provide necessary topsoil material from off-site sources (any stockpiled topsoil on the site shall also be used). The suitability of material supplied by Contractor shall be as defined elsewhere in these Earthwork Specifications. Contractor shall provide the Geotechnical Engineer access to proposed off-site sources to take samples and evaluate the materials.

K. DISPOSAL OF MATERIALS

(1) Surplus soil materials remaining after completion of fill placement and construction of berms shall be removed from the site and disposed of in legal manner, unless directed by the Owner to stockpile on-site for future use. Stockpile locations shall be as authorized by the Owner.

(2) Removal and disposal of existing utility pipes and structures, construction debris, or other obstructions which interfere with proposed construction and which are not indicated in the Agreement between Owner and Contractor as a separate pay item shall be considered incidental to the earthwork operations.

(3) Contractor shall be responsible for finding locations and obtaining approvals for the off-site disposal of demolition and construction debris, rubbish, pavement materials, shrubs, trees, and surplus, unsuitable excavated soil materials. Owner shall be advised, in writing, of the specific locations of all off-site disposal sites.

L. STORMWATER STORAGE BASINS

(1) Project stormwater storage basins shall be excavated and graded in conformance with the Plans. Basins shall be over excavated and impervious clay fill shall be placed where required by the Plans or as directed by the Geotechnical Engineer to seal areas of granular material.

(2) A geomembrane liner (60 mil textured HDPE, or as specified on the Plans) with welded seams and a 12-inch sand cushion shall be used to seal granular subgrade areas when indicated on the Plans.

(3) Shoreline erosion protection measures shall be provided as indicated on the Plans.

(4) Erosion protection in the form of stone riprap, gabions or mattresses, concrete block revetments, or concrete headwalls and mats may be required at pipe inlets and outlets and at basin overflow locations. The type and amount of protection to be provided shall be as indicated on the Plans.

4. SANITARY SEWERS, STORM DRAINAGE AND WATER SUPPLY SYSTEMS

A. GENERAL

(1) REFERENCE SPECIFICATIONS

(a) Sanitary sewers, storm drainage, and water supply improvements shall be constructed in accordance with the material, installation and testing requirements of the Division 61 of the Oregon Administrative Rules and local requirements except where said requirements are modified by these Project Site/Civil Technical Specifications.

(b) References to "ODOT" requirements or standards shall mean in conformance to the material, installation, and testing requirements of the current edition of the ODOT Standard Specifications.

(2) UNSUITABLE SOIL CONDITIONS

(a) When unsuitable soil conditions are encountered under pipes or structures that require the removal of unsuitable materials below the depth of the standard bedding, the Contractor shall replace the material removed with granular material approved by the Geotechnical Engineer. Depth and extent of removal shall be as determined by the Geotechnical Engineer.

(b) Unless defined otherwise in the Agreement between Owner and Contractor, payment for unsuitable soil removal shall be made at the contract unit price per cubic yard of soil removed and replaced with granular material. Unless defined otherwise in the Agreement between Owner and Contractor, the cost of removing and disposing of the unsuitable material and supplying and placing the granular fill and any dewatering required during these activities shall be considered incidental to the various pay items of the work.

(3) PIPE BEDDING, HAUNCH SUPPORT & INITIAL BACKFILL

(a) Concrete pipe, clay pipe, ductile iron pipe, cast iron pipe, and other types of pipe classified as rigid shall be placed on a 6-inch layer of compacted granular bedding material. This granular material shall also be placed on each side of the pipe (haunch support) from the top of bedding up to the horizontal midpoint of the pipe. Granular bedding and haunch material shall consist of graded crushed stone 1/4 inch to 3/4 inch in size (ODOT 3/4" aggregate base course), unless otherwise specified on the Plans.

(b) Thermoplastic pipe (e.g., PVC and HDPE), corrugated metal pipe, and other types of pipe classified as flexible shall be supported with granular bedding, haunching, and initial backfill in accordance with ASTM D2321, except as hereby modified. Class I embedment material (angular graded stone) 1/4 inch to 3/4 inch in size (ODOT 3/4" aggregate base course) shall be used as bedding, haunching, and initial backfill material and initial backfill material shall be installed to 12 inches above the top of the pipe.

(c) Where a pipe projects from an embankment or natural ground, the last 3 feet of bedding and backfill at the pipe end shall be impervious material compacted in place.

(d) Unless otherwise stated in the Agreement between Owner and Contractor, the cost of providing and placing granular bedding, haunch support, and initial backfill material shall be included as part of the fixed price or unit prices for sewer / culvert or main construction of the sizes and types specified.

(4) GRANULAR BACKFILL

(a) Selected granular material shall be used to backfill excavated trenches under all existing and proposed vehicle pavements and sidewalks, trenches with edges closer

than 2 feet from edges of existing and proposed vehicle pavements and sidewalks, and where specifically indicated on the Plans. Selected granular material for backfilling trenches shall be ODOT 3/4" aggregate base course, unless otherwise indicated.

(b) Porous (free-draining) granular material, shall be used as backfill in accordance with project plans and as defined in the geotechnical report.

(c) Well-graded granular backfill material placed in trenches under existing and proposed pavements shall be placed in lifts (8-inch maximum loose thickness) and mechanically compacted to not less than 95% of maximum dry density, as determined by the Modified Proctor Method (ASTM D1557). Porous (free-draining) granular material shall be placed and compacted as specified by the Geotechnical Engineer.

(d) Granular backfill placed in trenches located adjacent to pavements shall be jetted and water soaked, in lieu of mechanical compaction, if and where indicated on the Plans.

(5) FLOWABLE FILL

(a) When indicated on the Plans or specified by the Engineer, Controlled Low-Strength Material (CLSM) shall be used to backfill trenches or excavations. CLSM shall consist of a mixture of Portland cement, fly ash, fine aggregate and water proportioned to provide a backfill material that is self-compacting and capable of being excavated with hand tools, if necessary, at a later date. Materials, proportioning, placement and other requirements shall be as indicated in the ODOT Standard Specifications.

(6) TRENCH CASING PIPES

(a) Where indicated on the Plans or specified by Engineer utility pipes shall be installed in a watertight casing pipe placed in the excavated trench.

(b) Trench casing pipes shall be one of the following materials and meet the specifications noted. The type of material shall be as indicated on the Plans.

(i) Ductile Iron Pipe (AWWA-C151, class 50) with rubber gasket push-on joints (AWWA-C111).

(ii) PVC Pressure Pipe (AWWA-C900 or C905, DR25) with rubber gasket joints.

(iii) Steel Pipe (ASTM A139, Grade B, minimum yield strength 35,000 psi, minimum wall thickness 0.375 inch) with welded joints.

(c) The utility pipe shall be inserted into and supported within the casing pipe by the use of non-metallic (polymer) casing spacers. The spacers shall be configured to provide restraint against utility pipe movement due to flotation. Spacers shall be placed at 8-foot (or less) intervals, except that polyethylene and PVC pipes shall be supported at 6-foot (or less) intervals. In all instances, spacers shall be placed to support the utility pipe within 2 feet of each side of the pipe joints and within 2 feet of the ends of the casing pipe.

(d) When indicated on the Plans, the utility pipe shall be installed with self-restraining casing spacers that provide axial thrust restraint to prevent pipe joint separation. Restrained casing spacers shall be provided at all pipe joints and at 8-foot (or less) intervals; except that polyethylene and PVC pipes shall be supported at 6-foot (or less) intervals.

(e) The void space between the casing pipe and the utility pipe shall be filled with sand or other approved material when indicated on the Plans.

(f) Ends of the casing pipe shall be sealed with rubber end seals secured in place with stainless steel bands.

(7) STRUCTURE ADJUSTMENT

(a) Structure castings shall be adjusted to meet final ground and pavement surface elevations. Adjustments shall be made by adding or removing 24-inch I.D. adjusting rings or structure I.D. precast concrete riser sections. Total height of 24-inch I.D. adjustment rings shall not exceed 12 inches.

(b) The minimum thickness of a precast concrete adjusting ring shall be 2-inches and no more than two adjustment rings shall be used. No more than one 2-inch concrete adjustment ring shall be used.

(c) Precast concrete adjusting rings shall be used, except where the use of high-density polyethylene (HDPE) plastic or recycled rubber adjusting rings is indicated on the Plans. Concrete, HDPE, and rubber adjusting ring requirements shall be as indicated in the ODOT Standard Specifications.

(d) Structure adjustments shall be included in the prices of the utility structures being installed or modified and will not be paid for separately.

(8) MARKER POSTS

(a) Sewer and water main structures, valve boxes, and the end location of sewer stubs and building services shall be marked with a 4″ x 4″ x 8´ wood post. Four feet of the post shall stand aboveground. The top 6 inches of the post shall be painted to identify the type of utility (sanitary - green; storm - yellow; water - blue).

(b) Providing and installing marker posts shall be incidental to the cost of sewer and water main construction.

B. SEPARATION OF WATER MAINS AND SEWERS

(1) HORIZONTAL SEPARATION

(a) Shall follow local requirements.

(2) VERTICAL SEPARATION

(a) Shall follow local requirements.

C. SANITARY SEWERS

(1) SANITARY SEWERS

(a) See separate specification section 33 3100.

(2) MANHOLES

(a) Manhole Type 1 (proposed sewers):
Sanitary manholes shall be of precast concrete unit construction (ASTM C478) with an offset cone and with tongue and groove, watertight, rubber gasket joints (ASTM C443). Manholes shall be 48-inch inside diameter (unless otherwise indicated on the drawings) and (except for pump station manholes) shall have a single unit precast invert, bench and base.

(b) Drop manhole connections shall be as indicated on the Plans.

(c) Where frame casting adjustment to final grade is necessary, only precast concrete adjustment rings (24-inch inside diameter) and manhole riser sections (full diameter) shall be used, except that HDPE or rubber adjusting rings shall be used where indicated on the Plans. Maximum height of adjustment rings shall be 12 inches. No more than two adjustment rings shall be used. No more than one 2-inch (minimum thickness) concrete adjustment ring shall be used.

(d) Watertight resilient rubber gasket assemblies (ASTM C923) shall be provided at sanitary sewer-manhole connections. These gaskets shall be fastened to the sewer pipes with stainless steel clamps (ASTM A20).

(e) Frame and lid castings shall be in accordance with local requirements and as shown on the Plans.

(f) Frame and lid castings and all adjustment rings shall be set on a continuous layer of non-hardening preformed bituminous mastic material placed between the two adjacent components.

(g) Cast iron manhole steps shall be provided on a straight vertical alignment at 16-inch spacing. Steps shall be embedded 4 inches (minimum) into the manhole wall and shall be anchored in place with hydraulic grout. Manhole steps shall be Neenah R-1981-I with a polypropylene coating, MA industries PS-I-PF, or approved equivalent.

(h) An external type rubber sleeve and steel band assembly (manhole chimney seal) shall be installed to seal all joints between adjustment rings, frame casting and top riser section. Chimney seals shall be as manufactured by Cretex Specialty Products or an approved equivalent.

(3) GREASE INTERCEPTOR AND SEPTIC SYSTEM STRUCTURES

(a) Grease interceptor tanks and septic system structures shall be as indicated on the Plans.

(b) Access manholes and frame/lid castings shall be in accordance with the Plans and MANHOLES section above.

(c) Access manholes shall be provided with steps and external type chimney seals in accordance with the MANHOLES section above.

(d) Wall openings at pipe connections shall be sealed with rubber gasket assemblies in accordance with the MANHOLES section above.

(e) Top slabs of septic system structures shall be provided with a 24-inch-diameter opening and access lid (with two steel lift rings) in the center of each chamber.

(f) All interior concrete surfaces above the water line and extending at least 4 inches below the water line shall be covered with a 15-mil (minimum thickness) coal-tar epoxy coating.

(4) SEWAGE PUMPING FACILITY

(a) Pumping facility structure and equipment requirements shall be as indicated on the Plans and specifications 22 1329 and 22 1343.

(5) CONNECTIONS

(a) Connections of sewer pipes of dissimilar materials shall be made with adapter couplings specifically designed for the materials being connected or with a flexible rubber coupling sealed with stainless steel clamps.

(b) Connections to existing manholes shall be made by core drilling the manhole wall and installing watertight resilient rubber gasket assemblies (ASTM D923) complete with stainless steel clamps (ASTM A20).

(c) Service connections to existing sewer mains shall be made by core drilling the sewer main and installing a PVC hub, rubber sleeve and stainless steel band assembly (Inserta Tee™ by Fowler Manufacturing Co. or an approved equal).

(d) Tee fittings shall be provided on sanitary sewer mains for all building service sewer connections, except those that are made directly to a manhole.

(e) Service connections into new manholes shall be made with uniform semi-circular flow channels at the invert elevation of the sewer main.

(f) Riser pipes shall be provided on building service sewers, where indicated on the Plans, to connect the service sewers to a deep sewer main.

(6) SEWER FLOW CONTROL

(a) When installing replacement sewers or repairing existing sewers, suitable precautions and procedures must be used to maintain sewage flow and prevent significant backup of sewage in the existing sewers. If necessary, suitable equipment (pumps, conduits, etc.) shall be used to pump and bypass sewage around the sewer section being replaced or repaired.

(b) When sewer flow control is required and pumping and bypassing is not feasible, water services to buildings serviced by the sanitary sewer may be shut off to eliminate sewage flow, if the shut off is approved by Owner and is in accordance

with Engineer recommendations. Procedures and schedules for water service shutoffs shall be as required by the Water System Authority.

D. STORM DRAINAGE AND LEACHATE SYSTEMS

(1) PIPE MATERIALS

(a) See separate specification section 33 4200.

(b)

(2) DRAINAGE STRUCTURES

(a) Storm manholes, catch basins, and inlets shall be of precast concrete unit construction (ASTM C478). Details and dimensions shall be as indicated on the structure detail drawings included in the Plans.

(b) The type of frame and grate/lid casting to be provided on each storm structure shall be as indicated on the Plans.

(c) All joints between the various structure components (base, risers, cone, top slab, adjustment rings and frame casting) shall be sealed with a continuous layer of non-hardening, preformed flexible joint sealant (ASTM C990) placed between the two adjacent components; except that watertight (ASTM C443) rubber gasket joints between adjacent precast sections shall be provided where indicated on the Plans.

(d) Soil-tight (ASTM C1478) or watertight (ASTM C923) resilient rubber gasket assemblies shall be provided at sewer-structure connections where indicated on the Plans. These gaskets shall be fastened to the sewer pipes with stainless steel clamps (ASTM A20).

(e) Drainage structures within pavements shall be provided with subsurface drains as indicated on the Plans. Drain pipes shall be located at a level approximately 12 inches above the invert of the lowest sewer pipe connected to the structure.

(f) Manholes and catch basins more than 5 feet deep (to sewer invert) shall be provided with cast iron steps set on a straight vertical alignment at 16-inch spacing. Steps shall be embedded 4 inches (minimum) into the structure wall and anchored in place with hydraulic grout. Steps shall be Neenah R-1981-I or approved equal.

(g) Drainage structures other than circular manholes, catch basins, and inlets shall be of monolithic or sectional precast concrete construction designed for structural loading according to ASTM C890 and made in accordance with ASTM C913. Joints shall be sealed as indicated in above. Steps shall be provided in accordance with the above.

(h) Sewer outlet and culvert headwalls shall be as indicated on the Plans.

(3) FLARED END SECTIONS

(4) See plans and separate specification section 33 4200.SMALL SURFACE DRAINAGE INLETS

(5) See plans and separate specification section 33 4200PAVEMENT SURFACE DRAINS

(6) See plans and separate specification section 33 4200PIPE CONNECTIONS

(a) Connection of sewer pipes of dissimilar materials shall be made with adapter couplings specifically designed for the materials being connected, or with an approved neoprene coupling sealed with stainless steel bands.

(b) At pipe connections to new structures, the wall openings around the pipes shall be sealed with hydraulic grout except where the installation of soil-tight (ASTM C1478) or watertight (ASTM C923) resilient rubber gasket assemblies (complete with stainless steel clamps, ASTM A20) is indicated on the Plans.

(c) Pipe connections to existing structures shall be made by core drilling the structure wall and sealing the wall openings around the pipes with hydraulic grout; except where and the installation of soil-tight (ASTM C1478) or watertight (ASTM C923) resilient rubber gasket assemblies (complete with stainless steel clamps, ASTM A20) is indicated on the Plans.

(d) Contractor shall notify Engineer of any field tile discovered during the course of project construction to determine appropriate tie-in or abandonment requirements.

(7) EROSION PROTECTION

(a) Erosion protection in the form of stone riprap, gabions or mattresses, concrete block revetments or concrete mats (precast or fabric formed) may be required at pipe inlets and outlets and at stormwater basin overflow locations. The type and amount of protection to be provided shall be as indicated on the Plans.

(b) Stone riprap shall be provided in accordance with the plans and specification section 31 3700.

(8) TESTING

(a) All leachate piping shall be tested for leakage by means of the test method (exfiltration, infiltration or air-test) if, or as, required by the Governing Agency. Maximum allowable infiltration shall be 100 gallons per inch diameter per mile per day, unless otherwise specified by the Governing Agency.

(b) Flexible plastic pipe shall be tested for excessive deflection if, or as, required by the Governing Agency or ODEQ.

(c) Leachate piping shall be subject to a television inspection if, or as, required by the Governing Agency.

(d) Leachate manhole shall be vacuum tested for leakage and water tightness in accordance with ASTM C969-94, ASTM C1244-93, if, or as, required by the Governing Agency.

(e) The cost of leakage testing, air, and deflection testing shall be included as part of the fixed price or unit prices for leachate piping construction of the sizes and types specified.

E. WATER SUPPLY SYSTEMS

(1) PIPE MATERIALS

Water mains and service lines shall be constructed of one or more of the following materials and shall meet the specifications noted. The type of pipe material shall be as indicated on the Plans.

(a) Water mains and services lines of 3 inch or larger diameter -- Ductile Iron Pipe, Class 52 (AWWA C151) with cement mortar lining (AWWA C104) and rubber gasket, push-on joints (AWWA C111). Fittings shall be of ductile iron with cement mortar lining and mechanical joints and conform to AWWA C153 or AWWA C110.

(b) Water mains and service lines of 4 inches or larger diameter -- Polyvinyl Chloride (PVC) Pressure Pipe and Fittings (4″-12″ AWWA C900, DR 18 or less; 14″-48″ AWWA C905, DR 26 or less) with rubber gasket joints (ASTM D3139 and F477). Ductile iron fittings (AWWA C153 or AWWA C110) shall be provided if indicated on the Plans.

(c) Water mains and service lines of 4 inch and larger diameter -- Polyethylene (PE) Pressure Pipe and Fittings (AWWA C906, DR 17 or less for PE 3408 and DR 13.5 for PE 2406 and PE 3406) with thermal butt fusion pipe and fitting connections (except where a mechanical joining method is necessary to connect PE pipes to valves and or other material pipes/fittings).

(d) Water service lines of less than 3 inches in diameter -- Seamless Copper Water Tube, Type K, soft temper, for underground installation conforming to ASTM B88 and B251. Fittings shall be compression type only.

(e) Water service lines of 3 inches or less diameter – Polyethylene (PE) Pressure Pipe and Tubing (AWWA C901, DR 11 or less for PE 3408 and DR 9 or less for PE 2406 and PE 3406) with butt fusion pipe and fitting connections (except where a mechanical joining method is necessary to connect PE pipes to valves or other material pipes/fittings).

(2) VALVES

(a) Water main valves and service line valves (3 inch and larger) shall be Resilient Seated Gate Valves manufactured to meet all requirements of AWWA C509 or AWWA C515 and shall have a non-rising stem (open left), 2-inch square operating nut and two O-ring packing seals. Bonding or rubber sealing surfaces to cast iron wedge shall meet ASTM D429. Valve ends shall have mechanical joints, except for hydrant auxiliary valves that shall have a flanged joint on one end.

(b) Valves used for pressure connections to existing water mains shall be "Tapping" Resilient Seated Gate Valves specifically manufactured for this purpose and shall meet the requirements of AWWA C509 or AWWA C515. Tapping valves shall have one flange end and one mechanical joint end and shall be furnished complete with a two-section mechanical joint "tapping" sleeve.

(c) Valves installed on existing water lines (other than pressure connections) shall be "Cut-In" Gate Valves specifically manufactured for this purpose. Cut-in valves shall be furnished complete with a cut-in sleeve. Valve ends and one end of the sleeve shall be of mechanical joint construction.

(d) Insertion valves or line stops, installed with water main under pressure, shall be installed if and as indicated on the Plans.

(3) VALVE BOXES

(a) Valves shall be placed within boxes as indicated on the Plans.

(4) SERVICE LINE APPURTENANCES

(a) Service line valves of 3-inch and 4-inch size shall be provided with a screw type adjustable cast iron valve box set over the operating nut. The valve box shall be the two-piece Buffalo Type with a 5¼-inch shaft. The word "WATER" shall be imprinted on the lid.

(b) Water services of less than 3-inch diameter shall have a corporation stop, curb stop and curb box as specified on the detail drawings included in the Plans. If these items are not specified on the Plans, they shall be as required by the Governing Authority.

(5) WATER MAIN SHUTDOWN AND REOPENING

(a) Procedures and schedules for shutting down and draining sections of existing water main (for connection or reconstruction purposes) and for opening the water main sections for use again shall be as required by the Water System Authority.

(b) Contractor is responsible for contacting the Water System Authority and for making all necessary arrangements.

(6) PRESSURE CONNECTIONS

(a) Where so indicated on the Plans, connections to existing water mains shall be pressure connections utilizing a tapping sleeve and valve for new lines of 3-inch or larger diameter.

(b) Water services of less than 3-inch diameter shall be connected to existing mains by means of a corporation stop. A strap saddle shall be provided if required by the Water System Authority.

(7) BRACING AND ANCHORING

(a) All fittings and hydrants shall be properly braced by means of concrete thrust blocks. Where conditions prevent the use of thrust blocks, restrained joints or tie rods of a type approved by Engineer shall be used.

(b) All joints on vertical bends of 11¼ degrees or greater and all pipe and fitting joints within 20 feet of the vertical bend shall be properly anchored by means of a ductile iron retainer gland or other restraint device as shown on the plans or approved by Engineer.

(8) DEPTH OF COVER
   (a) Minimum depth of pipe cover for mains and service lines shall be in accordance with Plans and local requirements.
   (b) Where the required minimum depth of cover cannot be provided, an envelope of thermal insulation material shall be placed around the water pipe. Insulation material shall be "Gellsulate 500 XR" or approved equal. Installation details shall be in accordance with the material manufacturer's requirements and recommendations.

(9) TESTING
   (a) All water mains shall be pressure tested at 150 psig for a duration of at least 2 hours if, or as, required by Water System Authority.
   (b) After completion of the pressure test, a leakage test shall be performed if, or as, required by Water System Authority. Each leakage test shall be for a duration of 1 hour (minimum) in addition to the pressure test period. Allowable leakage shall be as indicated by Water System Authority requirements.
   (c) Disinfection of water mains shall be in accordance with AWWA C651 and accomplished by the liquid chlorine method, or as otherwise required by Water System Authority.

5. PAVEMENT CONSTRUCTION

A. GENERAL
(1) All roadway, driveway, parking area, storage area, and sidewalk pavements (including curbs and shoulders) shall be constructed in accordance with the material and installation requirements of the current edition of the ODOT Standard Specifications, except where said requirements are modified by the following Project Site/Civil Technical Specifications.
(2) Pavement markings and markers, and traffic control signs and devices, shall be provided, installed, and removed in accordance with the requirements of the ODOT Standard Specifications, except where said requirements are modified by the following Project Site/Civil Technical Specifications.

B. PAVEMENT REPLACEMENT/REPAIR
(1) Existing pavements removed for excavation purposes or damaged by construction operations shall be removed and replaced in conformance to the material and construction requirements of the ODOT Standard Specifications and the requirements of the subsequent portions of this specification section.
(2) Asphalt and concrete pavements shall be sawcut prior to excavation. Damaged or jagged pavement edges shall be neatly sawcut and removed prior to installing new pavement.
(3) Replacement material types and thickness shall be as indicated on the Plans.
(4) Pavement repair limits shall be as indicated on the Plans. Pavement repairs outside of these limits shall be at the Contractor's expense.

C. SUBGRADE PREPARATION
(1) Prior to placement of pavement material, all subgrade areas shall be proof-rolled to check for possible unsuitable or unstable soil conditions. Proof-rolling shall be witnessed by the Geotechnical Engineer. Should unsuitable or unstable material be encountered within pavement areas, unsuitable/unstable material shall be removed to a depth as described in the Earthwork Section of these Project Site/Civil Technical Specifications. Such materials shall be replaced with suitable structural fill material and compacted in place as specified by Geotechnical Engineer. When complete removal of the unsuitable material is not

warranted or feasible, remedial procedures (as required by Geotechnical Engineer) shall be used.

(2) Installed structural fill and excavated subgrade damaged by construction traffic, ponded water, or other causes within Contractor's control shall be replaced or repaired at Contractor's sole expense.

D. GEOTEXTILE FABRIC

(1) Where indicated on the Plans, a ground stabilization geotextile fabric (MIRAFI 600X or approved equal) shall be placed on the subgrade prior to installation of the aggregate pavement material. Installation shall be in accordance with the manufacturer's guidelines.

(2) Prior to placing the fabric, the earth subgrade shall be rolled and compacted with a smooth roller to seal the subgrade surface.

(3) In the event of excavation within or across previously installed aggregate base material, new geotextile fabric shall be installed to replace the fabric removed. Replacement procedures shall be as required by the Engineer.

E. PAVEMENT MATERIALS

(1) Various pavement types, materials, and thicknesses shall be as indicated on the Plans.

(2) Aggregate base courses shall be ¾" minus aggregate base course and shall conform with the geotechnical report and ODOT Specifications.

(3) Hot-mix asphalt (HMA) pavement materials and mixtures shall be in accordance with the ODOT Standard Specifications (section 00745) and the geotechnical report.

(4) HMA Mixture Requirements

| Item | Mixture | AC Type |
|---|---|---|
| Surface Course | HMAC, Level 2 | see geotech report |
| Binder Course | HMAC, Level 2 | PG 64-28 (see geotech report) |

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(5) Bituminous prime coats shall be in accordance with ODOT. Application rates shall be as specified by the Engineer:

(6) Portland cement concrete (PCC) for curbing, vehicle pavements, sidewalks and support slabs on-grade shall conform to ODOT requirements and the geotechnical report

(7) PCC curbing shall have expansion joints complete with dowel bars (AASHTO M227), dowel bar assemblies and preformed joint filler (AASHTO M213). PCC curbing shall contain continuous reinforcing bars (AASHTO M31).

(8) Sub-base material under PCC pavements and curbing shall be ¾" minus aggregate base course.

(9) PCC pavements other than sidewalks shall be provided with contraction, construction, and isolation joints complete with load transfer dowel assemblies, tie bars, and joint material (poured sealer, preformed filler, or elastomeric compression seal) as indicated on the Plans. Joint components, materials, and construction shall be in conformance to applicable ODOT Standard Specifications.

F. PAVEMENT MATERIAL QUALITY CONTROL

(1) Hot Mix Asphalt Pavement

(a) The HMA supplier shall provide a written certification that the HMA material conforms to the Project Site/Civil Technical Specifications.

(b) Specified in-place percent compaction values shall be based on the representative laboratory densities provided by the HMA supplier for the various HMA design mixes to be installed.

(c) The installation of all HMA pavement components (base, binder, and surface courses) and placement lifts shall be inspected and tested to verify compliance with the specified material compaction, temperature, and lift thickness requirements.

(d) One in-place density test, to determine in-place percent compaction, shall be performed for each 2,000 square feet, or fraction thereof, of each lift of material placed during each day.

(e) Measurements to determine HMA temperatures at time of compaction and lift thicknesses shall be performed on a periodic basis during the HMA installation operations. The number of temperature and lift measurements shall be not less than the number of density tests performed during the operations.

(f) If the Project Site/Civil Technical Specifications require pavement cores of the completed work, one core shall be taken for each 4,000 square feet of the installed pavement area.

(2) Portland Cement Concrete Pavement

(a) The concrete supplier shall provide a written certification that the concrete mix is in accordance with the Project Site/Civil Technical Specifications.

(b) Concrete delivered to the work site shall be field-tested before placement to verify that the slump, temperature, and air content values of the material complies with the Project Site/Civil Technical Specifications. Air content, slump, and temperature shall be performed each time a set of test cylinders is prepared. If the air content does not conform to the Project Site/Civil Technical Specifications, additional tests shall be performed on each truckload of concrete until the air content is determined to be within the specified tolerance range. If slump values exceed the maximum specified amount, when excessive variation in the workability of the concrete is observed, or when excessive crumbling or clumping is observed along the edges of slip-formed concrete, additional slump tests shall be performed on the same, or subsequent, truckloads until slump is determined to be within the specified tolerance range.

(c) Representative samples of the concrete mix shall be placed in a set of five standard cylinders for compressive strength testing. The cylinder sets shall be delivered to the material testing laboratory within 32 hours of taking the samples. Two cylinders shall be tested for compressive strength 7 days after the samples were taken. Two cylinders shall be tested 14 days after the samples were taken. One cylinder shall be held in reserve. A sample set (five cylinders) for strength testing shall be taken for each class of concrete not less than once a day, nor less than once for each 100 cubic yards of each class of concrete poured in place.

(d) Concrete delivered to the work site shall be subject to Governing Agency limitations for haul time and material temperature.

G. COMPACTION

(1) Aggregate base course and HMA material shall be placed in layers and compacted. Layer thicknesses shall be as indicated in the applicable ODOT Standard Specifications for the various pavement components and materials. Where layer thickness variation is permitted, thicknesses installed shall be as determined by the Geotechnical Engineer to obtain required compaction and strength of material in place.

(2) Aggregate base course and granular sub-base materials shall be compacted to not less than 95% maximum dry density determined in accordance with the Modified Proctor Method (ASTM D1557).

(3) HMA binder and surface course mixtures, HMA base course, and HMA shoulder mixtures shall be placed and compacted in accordance with the requirements of the applicable ODOT Standard Specifications.

(4) Aggregate base course material shall be graded and compacted the same day it is placed on the subgrade.

H. GRADING AND SURFACE TOLERANCES

(1) Surface elevations of completed aggregate bases and sub-bases shall not exceed design surface elevations by more than 1/4 inch. Surface elevations less than design value shall be corrected by adding aggregate or by installing additional thickness of required HMA or PCC pavement material. Such additional HMA or PCC pavement shall be provided at Contractor's expense.

(2) Allowable final surface variations of HMA and PCC pavements (tested with a 10-foot straightedge) shall not exceed 1/4 inch, but Engineer has the right to require corrective measures when variations less than the specified tolerance cause obvious drainage problems. Corrective measures required when the allowable variation is exceeded shall be as indicated in ODOT Specifications.

I. PAVEMENT THICKNESS TOLERANCE

(1) HMA pavements that have a thickness deficiency of more than 10% shall be removed and replaced if required by Engineer.

(2) PCC pavements (including sidewalks and slabs on-grade) that have a thickness deficiency of more than ½ inch or 10% (whichever is less) shall be removed and replaced if required by Engineer.

(3) Determination of pavement thickness shall be as indicated in ODOT Specifications

(4) Thin pavement removal and replacement shall be at Contractor's expense.

J. PC CONCRETE PROTECTIVE COAT

(1) PCC vehicle pavements and PCC sidewalks immediately adjacent to vehicle pavements shall be given a protective coat treatment in accordance with ODOT Specifications.

K. PC CONCRETE CURING

(1) PCC pavement and sidewalks shall be cured in accordance withODOT Specifications.

(2) The curing period in all cases shall be at least 72 hours.

(3) Hot or cold weather concrete curing methods and time periods shall be in accordance with ACI 305 and ACI 306 for hot and cold weather respectively.

L. PAVEMENT MARKINGS AND MARKERS

(1) Pavement markings and markers shall be as indicated on the Plans.

(2) Pavement markings on driveways and parking areas shall be of a paint suitable for such use according to ODOT Standard Specifications. Materials, installation, and equipment shall meet the requirements of ODOT Standard Specifications. Required markings shall be as indicated on the Plans.

M. ACCESSIBLE PARKING SPACES

(3) Accessible parking spaces shall be in accordance with Oregon accessibility requirements. Pavement slopes across accessible parking stalls and adjoining access aisles shall be maximum 2%.

N. TRAFFIC CONTROL SIGNS

(1) Traffic control signs shall be provided as indicated on the Plans. All signs shall conform to applicable size, material, and installation requirements of the Oregon Manual of Uniform Traffic Control Devices and ODOT Specifications.

## 6. SOIL EROSION / SEDIMENT CONTROL AND SITE RESTORATION MEASURES

### A. GENERAL

(1) Contractor shall take suitable and sufficient measures to control soil erosion and sedimentation due to construction and site development activities. These measures shall be in substantial conformance with the principles, practices, and standards described in the Oregon Department of Enviromental Quality (ODEQ).

(2) Specific erosion/sediment control and restoration measures shall be as indicated on the Plans, as stated in these Project Site/Civil Technical Specifications, and as described in the "Storm Water Pollution Prevention Plan" (SWPPP). Contractor shall be responsible to prepare the SWPPP for the Project.

(3) Site clearing and excavation shall not proceed until a phased program for performing all required construction and restoration activities is prepared by Contractor and approved by Engineer. The purpose of this program is to control erosion and sediment problems by minimizing the extent of areas subject to erosion during construction and establishing permanent ground covers as soon as possible. The program shall include preparation of site plans indicating planned sequence and extent of specific construction and restoration areas.

(4) Contractor responsibilities shall include the maintenance and repair of all seeded, sodded, and planted surfaces until all specified vegetative covers within the project area are suitably established and erosion potential has ceased.

(5) Construction dewatering operations shall be designed and operated so that water discharged from the project site will meet State of Oregon water quality standards.

(6) Installation and maintenance of all required erosion/sediment control and restoration measures shall be subject to inspection by the Governing Agency. Deficient conditions shall be corrected when required by the Governing Agency.

### B. STABILIZATION PRACTICES

(1) Contractor shall limit removal of existing vegetated ground covers only to areas absolutely required to perform the project work. Structural sediment barriers shall be installed at the construction limits of the site as indicated on the Plans. Vegetation within areas that are protected by barrier fencing on the Plans shall not be disturbed during construction.

(2) Exposed soil surfaces shall be stabilized with vegetation and/or protective mulches or blankets or as required by the Landscaping Plans.

(3) Temporary seeding shall be employed when necessary due to seasonal limitations or temporary work stoppages. When seasonal weather conditions prevent seeding, sodding, or planting operations, sloped surfaces shall be blanketed or mulched with suitable material as a means of temporary erosion protection.

(4) Areas with permanent vegetative cover seeding shall be protected by applied mulch or erosion control blankets.

### C. SEDIMENT BARRIERS

(1) Temporary sediment barriers shall be installed where indicated on the Plans and maintained until soil surfaces have been stabilized with grass or other types of permanent cover. Such barriers shall be silt fences, compost filter socks, coir fiber logs, or other devices as indicated on the Plans.

(2) Work area perimeter temporary sediment barriers shall be installed prior to the start of site disturbance and earthwork operations.

(3) Storm sewer systems shall be installed as soon as earthwork operations permit. Drainage structures shall be graded to a subgrade level 12 inches below the structure rim to create temporary sediment traps unless otherwise indicated on the Plans.

(4) Geotextile filter fabric sediment barriers shall be installed over casting grates of drainage structures that receive surface runoff. Silt fence or compost filter sock barriers shall be placed around drainage structures where the use of filter fabric barriers over the grate is ineffective or not feasible and where silt fences or filter socks are indicated on the Plans. Structures requiring sediment barriers, and the types of barriers to be provided, shall be as indicated on the Plans.

(5) All sediment barriers shall be replaced or cleaned as necessary during construction when they become clogged or ineffective. All sediment traps shall be cleaned periodically during construction to allow them to operate effectively.

D. CONSTRUCTION INGRESS-EGRESS

(1) Construction ingress-egress shall be limited to defined paved driveway connections to adjacent public roadways or where indicated on the Plans. Construction exits shall be cleaned daily, as needed to prevent the spread of mud or debris on the public road pavement. Mud and debris shall be cleared from public roads whenever it occurs and as required by the Public Roadway Authority.

(2) Private roadways, driveways, parking lots, etc., used by construction vehicles and equipment shall be cleaned of mud and debris daily as needed to keep the pavements clean of such materials.

(3) Temporary aggregate pavements for ingress-egress of construction vehicles shall be installed where needed or as indicated on the Plans. These pavements shall be maintained and repaired by Contractor as necessary to enable use by vehicles during the entire construction project.

(4) Temporary pavement thickness, aggregate gradation, and geotextile fabric underlayment to be provided shall be as indicated on the Plans.

(5) The upper 8 inches of temporary aggregate access pavements shall be removed upon completion of construction activities and replaced with 8 inches of topsoil, graded to match the adjacent topography, and restored in accordance with the Plans.

E. WATER DIVERSION AND DEWATERING

(1) Methods for diverting water flow, controlling groundwater, and removing stormwater from work sites shall include erosion and sediment control measures as necessary to prevent erosion at pump discharge locations and to minimize the discharge of settleable solids.

(2) Stone or concrete block riprap protection, or other filtering measures, shall be provided at discharge locations when deemed necessary by Engineer.

(3) Sediment traps or water removal sump pits shall be provided when required by Engineer.

F. DUST CONTROL

(1) When dust blowing from construction sites may become a traffic hazard or a danger to the health or comfort to persons downwind, it shall be controlled either permanently or temporarily depending upon the state of development of the site. Dust control measures shall be taken when required by Governing Agency or directed by Engineer.

(2) Dust problems from active construction areas shall be kept under control by means of watering dry surfaces and/or the application of calcium chloride. Application and repetition rates shall be as necessary for effective control.

(3) In the event of severe dust problems, the Governing Agency may stop such dust-producing activities until the problem is resolved.

G. SOIL STOCKPILES

(1) Soil stockpiles shall be located to prevent sediment runoff into watercourses and drainage systems, or onto adjacent roadways and properties, and, if shown, shall be placed where indicated on the Plans. Stormwater runoff from soil stockpiles shall include erosion control devices as necessary to prevent erosion or sedimentation.

(2) Soil stockpiles to remain in place more than 15 days shall be surrounded with a sediment barrier fence unless runoff from the stockpile area drains directly to a constructed sediment trap.

(3) Soil stockpiles that will remain in place longer than 60 days shall be stabilized with temporary erosion control seeding (seed and mulch) within 15 days after construction of the stockpile.

H. UNVEGETATED AREAS

(1) Unvegetated areas expected to remain unpaved or unrestored for longer than 60 days shall be stabilized with temporary erosion control seeding and mulching within 15 days after earthwork operations have ceased.

(2) If unvegetated areas are to remain unpaved or unrestored for less than 60 days, sediment barrier fences or excavated sediment traps shall be installed if Engineer determines that sediment runoff will affect adjacent areas.

(3) Unvegetated steep slopes shall be protected by hydromulching the exposed ground with a Bonded Fiber Matrix, Stabilized Fiber Matrix, or Flexible Growth Medium product (applied at rates recommended by the product manufacturer for the site conditions) when such protection is indicated on the Plans or required by Engineer. Other unvegetated steep slope protection, if required, shall be as indicated on the Plans.

I. TOPSOIL PLACEMENT AND VEGETATIVE COVER

(1) Weather conditions permitting, topsoil shall be placed and graded within each defined construction area as soon as practical upon completion of cut and fill operations within that area.

(2) Seeding, planting and erosion protection operations to establish permanent vegetative ground cover shall be performed within 1 day after topsoil placement, whenever weather conditions are adequate for such work.

(3) Temporary erosion control measures shall remain in place until upland areas are permanently vegetated whereby a minimum of 80% of every square yard seeded is covered with a uniform stand of vegetation in a live, healthy condition and erosion potential no longer exists.

J. DRAINAGE OUTLETS AND OVERFLOWS

(1) Erosion protection (stone riprap, concrete block mats, or other specified method) shall be provided at drainage pipe outlets and stormwater basin overflows immediately following installation of the outlet/overflow structures.

K. DRAINAGE CHANNELS AND SWALES

(1) Drainage channel and swales shall be stabilized and protected with the installation of aggregate trench checks, a cellular confinement system, seeding, and/or turf reinforcement mat where and as indicated on the Plans.

L. EROSION CONTROL SEEDING AND MULCHING

(1) Areas which may not be at final grade but will remain undisturbed for longer than 60 days (including soil stockpile areas) shall be seeded and/or mulched, as required by Engineer, within 15 days of stoppage of construction activities within the area.

(2) Seed mixture to be used for temporary erosion control seeding of excavated, filled, graded, or otherwise disturbed areas shall be in accordance with ODOT requirements.
(3) Seed mixtures should be applied mechanically so that the seeds are planted at a depth of 1/4 to 1/2 inch. If the seed is broadcast or hydroseeded, secondary raking or harrowing is required.
(4) Seeded areas shall be protected with a blanket or other method in accordance with ODOT requirements.

M. PERMANENT VEGETATIVE COVERS
(1) Vegetative ground covers shall be provided, installed, and protected in accordance with the Plans and Landscape Plans.

N. EROSION CONTROL BLANKETS
(1) Seeded areas shall be covered with erosion control blankets where indicated on the Plans and Landscape Plans and where specifically required by Engineer. These blankets shall be placed within 24 hours of seeding.
(2) Contractor shall be responsible for maintaining the blankets in place until a satisfactory stand of vegetation is established.

O. PERMANENT SEEDING
(1) Where indicated on the Plans or Landscape Plans, vegetative areas disturbed by construction activities shall be restored by the proper application of fertilizer nutrients, seed mixture, and protective mulch or blanket, and maintenance of said areas until a satisfactory stand of vegetation is established.
(2) Contractor shall have complete responsibility for watering seeded areas (number, schedule, and rates of applications) as necessary to prevent death or damage of seeds and new vegetation due to lack of water, during the time period between seeding and when the vegetation becomes rooted in the soil and is growing in place.
(3) If Contractor does not water the seed and vegetation within 24 hours after notification that the seed and vegetation are showing damage due to lack of water, Owner reserves the right to engage another contractor to do the work and the cost thereof will be deducted from the monies payable to Contractor for the cost of seeding. Contractor will not be relieved of the responsibility for defective seed or unsatisfactory growing of seed due to the hiring of another contractor by Owner for watering the seed.
(4) Contractor shall be responsible for the maintenance of all areas seeded under the contract, including all necessary watering, reseeding, and remulching and for the satisfactory growth of vegetation on all seeded areas until final acceptance of the work. In the event that the length of time between seeding and final acceptance is insufficient for Engineer to determine that acceptable growth is established, final acceptance of the work will not be made until the following growing season or until such time that the vegetation cover can be appraised as satisfactory.
(5) Approval and acceptance of seeded areas will require that a minimum of 80% of every square yard seeded be covered with a uniform stand of vegetation in a live, healthy condition. Reseeding, remulching, and watering of unacceptable areas shall be at Contractor’s expense.
(6) Only areas within the defined construction limits that are authorized for topsoil replacement will be considered for payment for seeding. All other vegetation areas that are damaged by construction operations shall be seeded and restored at Contractor's expense.

# SPECIFICATION FOR CORRUGATED METAL PIPE

SLOTTED DRAIN™ - VARIABLE HEIGHT OR GREATER THAN 6 INCH GRATE – GALVANIZED STEEL

## 1.0 GENERAL

1.1 This specification covers the manufacture and installation of galvanized corrugated steel pipe (CSP) with Slotted Drain used for the removal of surface water as detailed in the project plans.

## 2.0 DESIGN STANDARDS

2.1 The CSP meets the design parameters of the American Association of State Highway and Transportation Officials (AASHTO) Standard Specification for Highway Bridges, AASHTO LRFD Bridge Design, and/or the American Iron and Steel Institute (AISI).

## 3.0 MATERIAL

3.1 The galvanized coils shall conform to the applicable requirements of AASHTO M 218 or ASTM A929.
3.2 The grate and extender plates (when utilized) shall be galvanized in accordance with ASTM A123, except with a 2 oz. galvanized coating, total both sides.

## 4.0 PIPE

4.1 The CSP shall be manufactured in accordance with the applicable requirements of AASHTO M 36 or ASTM A760. The pipe sizes, diameters, gauges, corrugations shall be as shown on the project plans.

4.2 All fabrication of the product shall occur within the United States.

## 5.0 GRATES

5.1 The grates shall be manufactured from ASTM A1011, Grade 36 steel. The spacers and bearing bars (sides) shall be 3/16" material ± 0.008".
5.2 The spacers shall be on 6" centers and welded on both sides to each bearing bar (sides) with four (4) 1-1/4" long 3/16" fillet welds on each side of the bearing bar.
5.3 Vertical (straight sides) grate with a 1-3/4" opening in the top and vertical spacers unless shown otherwise on the plans. The grate shall be 2-1/2" or 6" high as shown on the plans.
5.4 The engineer may call for tensile strength tests on the grate if the grate is not in compliance with Section 5.2. If tensile strength tests are called for, minimum results for an in-place spacer pulled perpendicular to the bearing bar shall be:
T = 12,000 pounds for 2-1/2" grate
T = 15,000 pounds for 6" grate
5.5 The grate shall be fillet welded with a minimum weld 1" long to the CSP on each side of the grate at every other corrugation.
5.6 Variable height grates shall be used to achieve the slope shown on the plans.
5.7 When side plate extender are utilized, they shall be 7 gage steel meeting ASTM A761 with minimum yield / tensile strengths of 28,000 and 42,000 respectively.

## 6.0 COUPLING BANDS

6.1 Modified HUGGER (7-5/8” wide) bands for the CSP shall be made of the same base metal and coatings as the CSP to a minimum of 18 gauge.
6.2 When the Slotted Drain is banded together, the adjacent grates shall have a typical gap of 2” - 3".
6.3 Ends of the CSP are rerolled with annular corrugations for proper indexing.
6.4 Connection fasteners will be provided.

## 7.0 TOLERANCES FOR FINISHED SLOTTED DRAIN OF 20' LENGTHS

7.1 Vertical Bow: ± 3/8"; Horizontal Bow: ± 5/8"; Twist: ± 1/2"

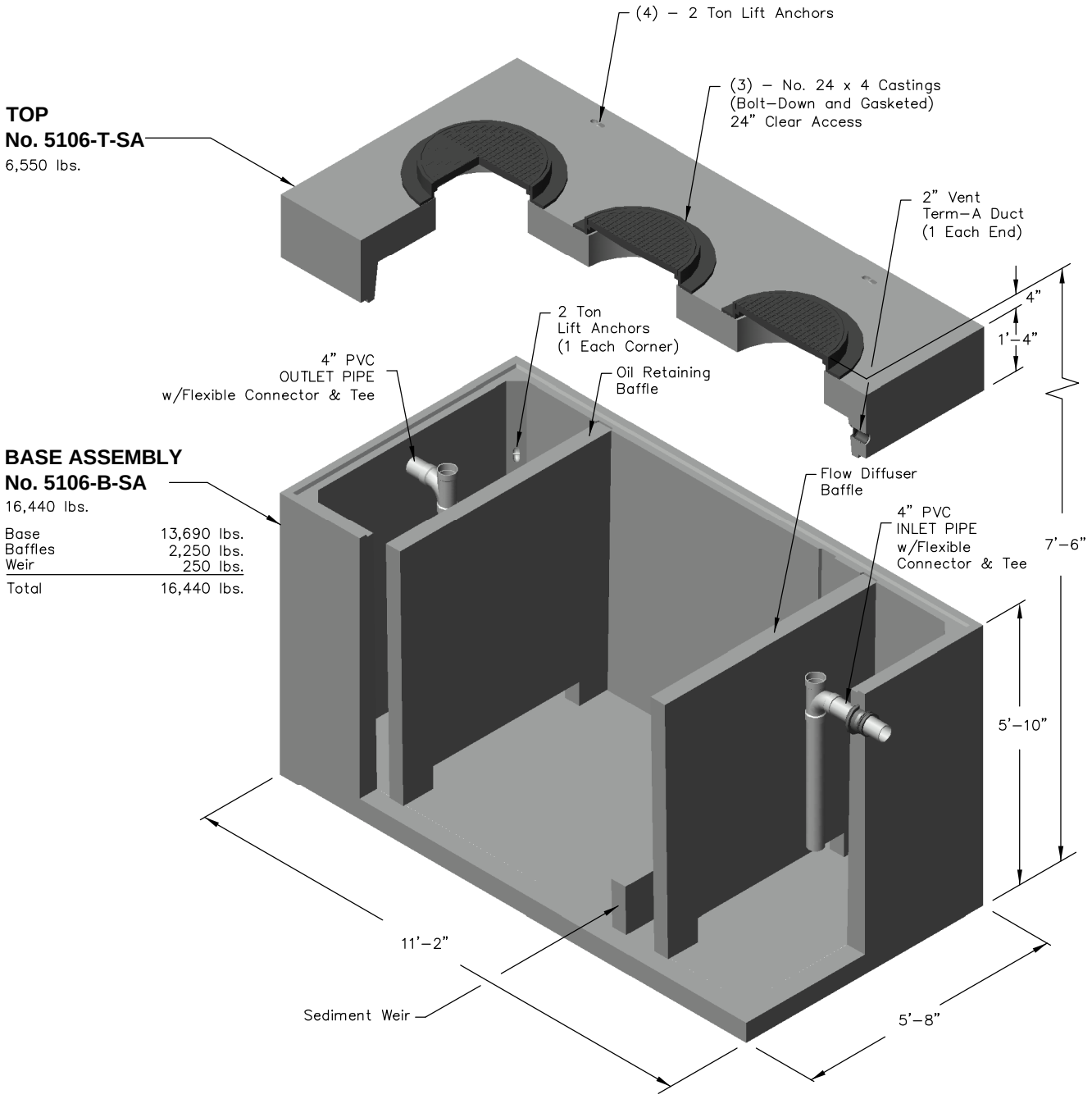
## 8.0 HANDLING, ASSEMBLY, & INSTALLATION

8.1 Refer to the recommendations of the National Corrugated Steel Pipe Association’s (NCSPA).
8.2 The installation shall be in conformance with the project plans and specifications or the manufacturer’s recommendations. If there are any inconsistencies or conflicts, the contractor must bring them to the attention of the project engineer.
8.3 It is always the contractor’s responsibility to follow OSHA guidelines for safe practices.

## 9.0 CONSTRUCTION LOADS

9.1 Construction loads may be greater than design loads. The contractor shall follow the of the manufacturer's guidelines.

# 5106-SA-1750




**TOP**
**No. 5106-T-SA**
6,550 lbs.

**BASE ASSEMBLY**
**No. 5106-B-SA**
16,440 lbs.

| | |
|---|---|
| Base | 13,690 lbs. |
| Baffles | 2,250 lbs. |
| Weir | 250 lbs. |
| Total | 16,440 lbs. |

**"IAPMO Listed"**

Note: Designed for 0 to 5'–0" of Cover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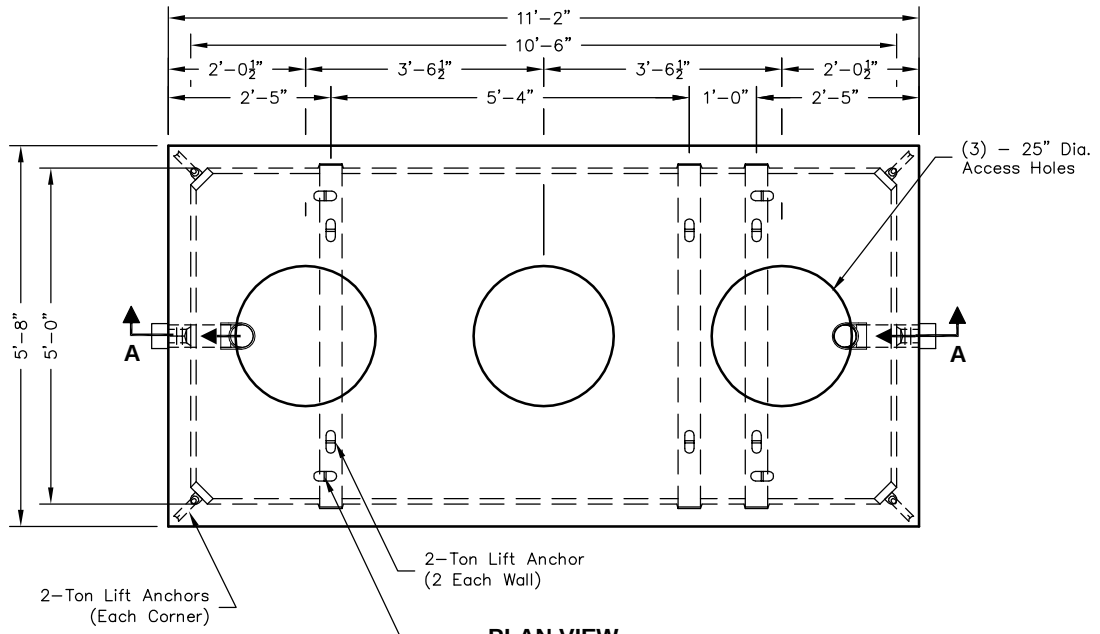
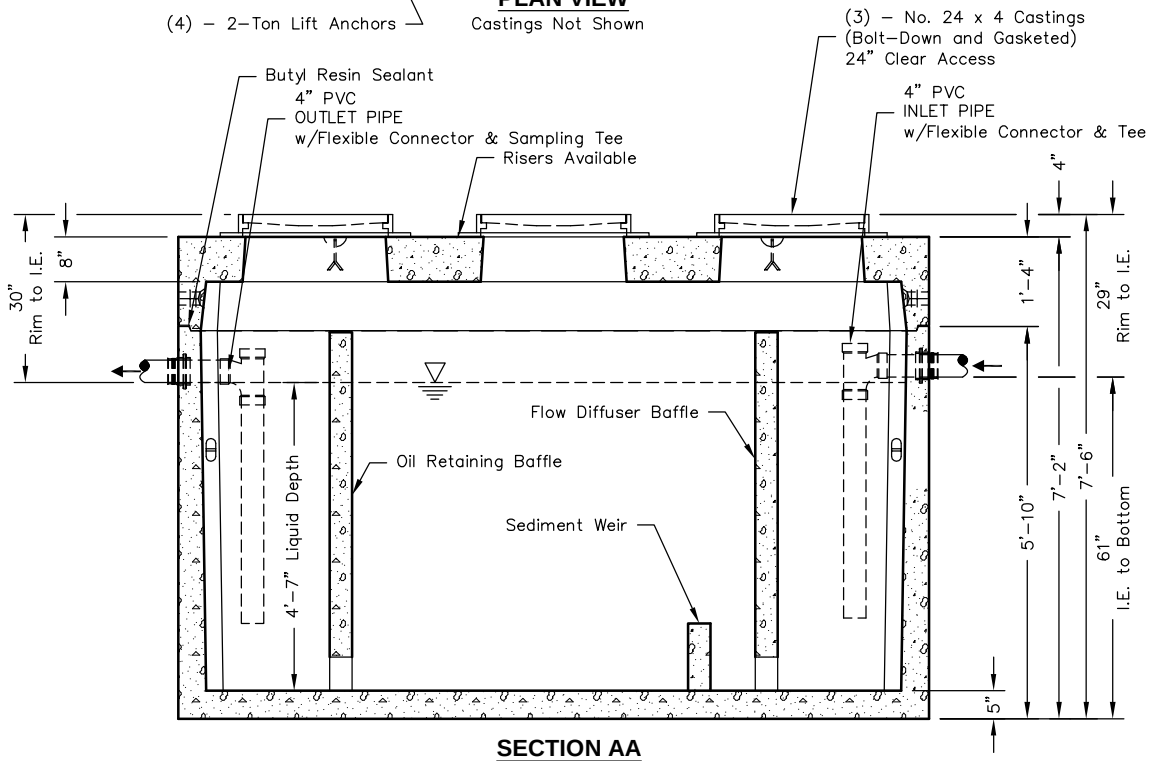
| | |
|---|---|
| **5106-SA-1750** | |
| File Name: 020-5106-SA-1750 | **5106-SA-1750 OIL / WATER SEPARATOR 1750 GALLON - API STYLE** |
| Issue Date: 2016 | |
| **oldcastleprecast.com/wilsonville** | |

# 5106-SA-1750




**PLAN VIEW**
Castings Not Shown




**SECTION AA**

Notes:
- Designed in accordance with ASTM C 890 for AASHTO HS20–44 vehicle loading
- Flow Rate 117 GPM based on 15 min. retention time.
- Manufacturer's recommendations:
  1.) Ventilate each end to open atmosphere.
  2.) Prior to "Start Up" of System, fill with clean water to bottom of outlet pipe (approx. one foot deep). For best results, fill to flow line.
  3.) Follow Regular Inspection, Cleaning, & Maintenance Schedule (See Clean Out & Maintenance).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| File Name: 020-5106-SA-1750 | |
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# GEOTECHNICAL EXPLORATION REPORT
# NEGUS RECYCLING & TRANSFER FACILITY
# 2400 NE MAPLE AVENUE
# REDMOND, OREGON

**October 23, 2020**

**Project No. 11301-1**

A Report Prepared For:

Mr. Jeff Shepherd
Civil & Environmental Consultants, Inc.
215 S. 4th Street, Suite 203
Vancouver, WA 98660

**GEOTECHNICAL EXPLORATION REPORT**
**NEGUS RECYCLING & TRANSFER FACILITY**
**2400 NE MAPLE AVENUE**
**REDMOND, OREGON**

Wallace Group Project Number 11301 (1)

Prepared By:

Adam Larson, P.E.
Staff Geotechnical Engineer

Lisa M. Splitter, P.E., G.E.
Senior Geotechnical Engineer

**The Wallace Group, Inc.**
62915 NE 18th Street, Suite 1
Bend, OR 97701

## EXECUTIVE SUMMARY

The Wallace Group, Inc., (Wallace Group) has completed a geotechnical-engineering exploration for the Negus Recycling & Transfer Facility improvements project, located in Redmond, Oregon (**Figure 1**, **Vicinity Map**). Boring and test pit exploration locations are shown on **Figure 2, Exploration Location Map**.

Based on review of a structure summary and Design Development plans provided by BLRB (project Architect), dated October 19, 2020, we anticipate significant improvements are planned for the existing Negus Transfer Station. Numerous structures and access drives will be constructed within the approximately 18-acre development area. The planned structures will typically be constructed with steel frames and have Concrete Masonry Unit (CMU) walls with slab-on-grade floors. The new structures will be approximately 11- to 48-feet tall. We understand the south side of the transfer station will have an elevated slab to accommodate loading of transfer trucks. The transfer station will have a retaining wall on the south side that will be approximately 15-feet tall. To accommodate fire suppression requirements, we understand a 500,000-gallon water tank is being considered east of the proposed Maintenance Building. Other improvements will include asphalt-paved access drives and parking areas, underground utility improvements, landscaping, security fencing, and stormwater collection and disposal.

Subsurface explorations generally encountered undocumented fill or native silty-sand, sand-with-silt, and gravel-with-silt-and-sand that extended up to 25.5-feet below ground surface (bgs). The fill and sand and gravel were underlain by basalt bedrock, which caused refusal to excavation equipment and auger drilling. The basalt bedrock was encountered at depths that ranged between 0.5 to 25.5-feet bgs, and the bedrock extended to depths up to approximately 25.8-feet, where the borings were terminated. Groundwater was not encountered within the depths explored.

Based on this exploration, the site appears suitable for the proposed development from a geotechnical perspective, provided the recommendations contained in this report are incorporated into design and construction. Key items are discussed in greater detail in the body of this report.



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This summary is intended for introductory and reference purposes only. A thorough review of the body of the report is necessary to fully understand the conclusions and recommendations contained herein.



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# 1.0 INTRODUCTION

## 1.1 GENERAL

The Wallace Group, Inc., (Wallace Group) has completed a geotechnical-engineering exploration for the Negus Recycling & Transfer Facility project, located at 2400 NE Maple Avenue in Redmond, Oregon (**Figure 1**, **Vicinity Map**). Boring and test pit exploration locations are shown on **Figure 2, Exploration Location Map**.

## 1.2 PROJECT DESCRIPTION

Based on review of concept plans by BLRB, dated October 19, 2020, we anticipate construction will include the construction of a new solid waste recycling and transfer facility (designated Buildings A through G). We understand the new facility will include a transfer station, office, maintenance building, recycling center, recycling office and loadout, inbound and outbound scales, and asphalt-paved streets and parking. Based on the information provided by BLRB, the footprints and finished floor elevations (FFE) of the new structures will be approximately:

- Transfer Station (Building A): 35,500 square feet, 48-feet-tall at FFE 3,043 feet (ft), msl
- Maintenance Building (Building B): 2,800 square feet, 26-feet-tall at FFE 3,041 ft, msl
- Scale House (Building C): 530 square feet, 14-feet-tall at FFE 3,033 ft msl
- Recycling Center (Building D): 11,100 square feet, unenclosed building at FFE 3,043 ft msl
- Recycling Office and Loadout (Building E): 5,300 square feet, 26-feet-tall at FFE 3,043 ft msl
- Recycling Pay Booth (Building F): 98 square feet, 11-feet-tall
- Organics Booth A (Building G): 501 square feet, 14-feet-tall
- Organics Booth B (Building G): 98 square feet, 11-feet-tall
- Water Tank: 500,000 Gallon

Based on review of a structure summary provided by BLRB, we understand the structures will typically be constructed with steel frames and have Concrete Masonry Unit (CMU) walls with slab-on-grade floors. We understand the south side of the transfer station will have an elevated slab to accommodate loading of transfer trucks. The transfer station will have a retaining wall on the south side that will be approximately 15-feet tall. To accommodate fire suppression requirements, we understand that a 500,000-gallon water tank is being considered east of Building B. Other improvements will include asphalt-paved access drives and parking areas, underground utility improvements, landscaping, security fencing, and stormwater collection and disposal.



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## 1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this design-level geotechnical exploration was to evaluate general subsurface conditions within the development areas in order to provide recommendations for foundation design and other geotechnical aspects related to site development. Our scope of services for this design-level investigation included the following tasks:

- Explore subsurface conditions by advancing eight geotechnical borings and eight test pits;
- Perform geotechnical engineering analyses and develop recommendations for shallow foundations, earthwork, site preparation, and excavations; and
- Prepare this design-level geotechnical report summarizing our findings, conclusions, and recommendations.



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## 2.0 FIELD EXPLORATION

### 2.1 SUBSURFACE EXPLORATION

Subsurface conditions were explored using drilled borings and test pit excavations. Eight (8) test pits, designated TP-01 through TP-08, were excavated to depths ranging from approximately ½ to 4½ feet below ground surface (bgs) on July 21, 2020. Test pits were excavated with a mini-excavator operated by Terry Shine Excavation of Bend, Oregon.

Eight (8) borings were drilled between July 20 and 22, 2020, designated B-01 through B-08, by Western States Soil Conservation, Inc. of Hubbard, Oregon. Borings were advanced using a truck-mounted, Central Mining Equipment (CME) 75 drilling rig, equipped with a hollow-stem auger (HSA) and HQ-wireline coring techniques. Borings were advanced to depths ranging from approximately 1/2 to 27 feet bgs.

Wallace Group geotechnical professionals monitored the borings and test pits and visually classified the materials encountered. The boring and test pit logs in **Appendix A** describe the materials encountered at each location explored. The soil types between explorations are anticipated to be similar; however, some variation should be expected. The stratigraphic contacts indicated at each exploration location represent the approximate boundaries between soil and bedrock types.

A more complete description of the exploration methods, sampling techniques and depths, and soil classification terminology is presented in **Appendix A, Field Exploration Summary**.

Additionally, representative soil and rock samples were collected for laboratory testing by Wallace Group professionals during the geotechnical exploration. Laboratory analyses and findings are shown on the logs and in **Appendix B**.



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## 3.0 LABORATORY TESTING

Select soil and rock samples were transported to our Bend geotechnical laboratory where they were visually classified according to the Unified Soil Classification System (USCS). The classification is based on the 'finer fraction' of soil and gravel particles smaller than three-inches in diameter.

Representative samples were tested to evaluate soil engineering properties. The tests were completed in general accordance with the following standards:

- Moisture Content, ASTM D2216
- Gradation Analyses, ASTM C117 / C136
- Classification of Soil for Engineering Purposes, ASTM D2487

The results of laboratory testing are presented in **Appendix B**.



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## 4.0 EXISTING SITE CONDITIONS

### 4.1 SURFACE

Currently, the subject property is substantially undeveloped, except for NE Negus Way and gravel stockpiles. Based on review of survey work by PBS Engineering and Environmental, dated August 2014, elevations across the development area range from approximately 3,025 to 3,047 feet mean sea level (msl). Several gravel stockpiles are present in the southeast portion of the development area and are up to 15-feet-tall. The remainder of the property is covered with native grasses and occasional juniper trees.

### 4.2 SUBSURFACE CONDITIONS

Subsurface explorations generally encountered undocumented fill or native silty-sand, sand-with-silt, and gravel-with-silt-and-sand that extended up to 25.5-feet below ground surface (bgs). The fill and sand and gravel were underlain by basalt bedrock, which caused refusal to excavation equipment and auger drilling. The basalt bedrock was encountered at depths that ranged between 0.5 to 25.5-feet bgs, and the bedrock extended to depths up to approximately 25.8-feet, where the borings were terminated.

#### *4.2.1 Fill Materials*

Fill materials were encountered in B-03, B-08, TP-02, and TP-03 and extended to depths ranging between 1- to 4.5-feet bgs. The undocumented fill materials consisted primarily of ¾-inch minus pea gravel and boulder fill. The boulder fill contained boulders up to 2.5-feet in diameter that were in a matrix of gravel and silty-sand soil. Deleterious items including plastic, metal, and residential waste were encountered. Due to the site's historical use we anticipate other deleterious items may be encountered during development.

#### *4.2.2 Silty-Sand, Sand-with-Silt, and Gravel-with-Silt-and-Sand*

Native silty-sand and sand-with-silt was encountered below the fill material or extending from the ground surface in all locations, except for TP-02 and TP-03. The native soil was generally fine to coarse grained sand and gravel, subangular to subrounded, moist, and brown to tan. Based on SPT's, the native material was medium dense to very dense. Where the native soil was underlain with basalt bedrock, the size and quantity of gravel and cobble generally increased near the contact point. The soil near the contact point was weathered-in-place basalt.

Gradation tests and field classification indicate the native soil generally classifies as a silty-sand (SM), poorly-graded-sand-with-silt (SP-SM), and poorly-graded-gravel-with-silt-and-sand (GP-



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GM) according to the USCS. Where tested, the soil samples contained between 6.4 to 19.4 percent clay- and silt-sized particles and had a moisture contents that ranged between 4.7 to 21.6 percent.

### *4.2.3 Basalt Bedrock*

Hard basalt bedrock was encountered in each boring and test pit and caused practical refusal with HSA drilling techniques and excavation equipment at depths ranging between 0.5 to 25.5-feet bgs. The basalt was vesicular and contained vesicles up to 2-inches in diameter in some locations. Based on the rock quality designation (RQD), the basalt rock generally ranged from very poor to good rock quality. Based on our prior experience, we anticipate the relative hardness of the basalt will range from R1 to R4 (see **Appendix A**). Significant voids were not encountered within the depth of explorations.

## 4.3 GROUNDWATER

Groundwater was not encountered in the explorations and should not influence site development. Localized perched water may occur at the soil/basalt interface during wet periods. A review of well logs obtained from the Oregon Water Resource Department indicates groundwater level is approximately 325 to 375 feet bgs in the project area.



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## 5.0 SEISMIC CONSIDERATIONS

The proposed new water tank meets the criteria for an essential facility as defined in Oregon Revised Statute (ORS) 455.447. Therefore, the 2019 State of Oregon Structural Specialty Code (OSSC) Section 1803.3.2 requires that a seismic site hazard investigation be conducted for certain classifications of structures, including Essential Facilities. This section of our report is intended to address the requirements of OSSC Section 1803.3.2.

The site is located at the western margin of the High Lava Plains Physiographic Province of Central Oregon, approximately five miles east of the Deschutes River. This region is characterized by semi-arid high desert vegetation along the eastern foothills of the High Cascade Mountain Range. Annual precipitation in the Redmond area is approximately 10 inches, most of which falls in the form of snow during the winter months.

The site and surrounding areas are composed of relatively thin volcanic soils overlying Pleistocene age Newberry basalt flows (Sherrod et al., 2004). The site is near the northeast terminus of the Newberry flows. These flows are generally composed of tholeiitic and calc-alkaline basaltic andesite in layered horizontal deposits emanating from the main caldera, as well as associated fissures and cinder cones. The site and surrounding area have typical volcanic topography for the area, with pressure ridges, inflated flows, surface cracking, and isolated lava tubes. With exception of talus deposits, lake sediments, and fluvial debris, most of the rocks in the province are volcanic, and thick accumulations of basaltic lava are common. The existing site elevations range from 3,047 feet mean sea level (msl) near the central portion of the site and slopes down to 3,025 to 3,040 feet msl near the site perimeter.

### 5.1 EARTHQUAKE SOURCES

There are two primary earthquake sources that have been identified in the project region: Cascadia Subduction Zone (CSZ) sources and shallow crustal sources. The CSZ sources are frequently subdivided into interface and intra-slab events. This combination of sources results in three earthquake source classifications: (1) shallow crustal earthquakes; (2) deep earthquakes with a moment magnitude greater than 7.0 on the seismogenic part of the subducting plate of the CSZ; and (3) an earthquake with a minimum moment magnitude of 8.5 on the seismogenic part of the interface between the Juan de Fuca Plate and the North American Plate in the CSZ. These are discussed in Section 1803.3.2 of the 2019 OSSC and are summarized below.



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For evaluating the earthquake ground motions at this site, we relied on the work of Geomatrix (1995) for the Oregon Department of Transportation (ODOT Report), and information published more-recently by the United States Geological Survey (USGS). The approach used for evaluating seismic conditions is based on the following:

Earthquake sources in Oregon are identified primarily from published geologic records rather than recorded seismic data. Of the three source mechanisms considered in OSSC Section 1803.3.2, recorded seismic data are available only for shallow crustal events. The potential for periodic, large-magnitude subduction zone events along the Oregon Coast is based primarily on geologic evidence, as large, subduction zone events are believed to occur at intervals of 500 to 600 years, but sometimes occur within the 100 to 300-year time frame. The most recent significant CSZ earthquake occurred in the year 1700, based on a tsunami recorded in Japan. As a result, there are significant uncertainties associated with evaluating many of the key parameters required to assess earthquake hazards.

To prepare the ODOT Report, Geomatrix assessed the seismic hazard in Oregon using probabilistic seismic hazard analysis techniques. That is, the analyses performed included addressing quantitatively the uncertainties associated with the required input parameters for each of the identified potential earthquake sources. Based on the results of the analyses conducted, earthquake ground motion maps were generated for the state of Oregon for 500-year, 1,000-year and 2,500-year return periods for peak ground acceleration and five-percent damped spectral accelerations at spectral periods of 0.3 and 1.0 seconds. Generalized elastic response spectra were also developed for various regions of Oregon based on the relative influence of subduction zone seismic sources and shallow crustal sources to the overall seismic hazard.

We also reviewed the 2020 USGS seismic maps for the state of Oregon. Information provided by the USGS is consistent with the Geomatrix report, for seismic events with return intervals of 2,500 years (approximately equivalent to the two percent probability of exceedance in 50 years), specified in the OSSC.

More recently, the USGS has revised the Seismic Design Maps based on 2016 ASCE 7. The Seismic Design Maps incorporate risk-based seismic design analyses.



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The following sections include more detailed descriptions of the potential seismic sources, the methods used to evaluate peak ground accelerations, the methods used to develop the site-specific response spectra, and a discussion of the specific seismic issues required by the Code.

### *5.1.1 Subduction Zone Sources*

An active subduction zone is located where the Juan de Fuca Plate is subducting beneath the North American Plate approximately 50 miles off the Oregon Coast. Earthquake types associated with the subduction zone include interface events at the boundary where two plates intersect and intra-slab events within the subducting Juan de Fuca Plate. Potential bedrock accelerations at the project site that may develop during subduction zone events should be similar throughout the Central Oregon region because the site and the region are about the same distance from potential subduction zone sources.

### *5.1.2 Crustal Sources*

In the analyses associated with the Geomatrix ODOT Report, crustal sources incorporated into the analyses modeled both regional source zones and specific identified geologic faults.

***Regional Zone:*** In this model, earthquakes are assumed to occur randomly within a general region. The advantage of this approach is that it allows provision for the possibility of unidentified or unknown fault sources. Maximum earthquake magnitudes are estimated for each source zone based on historic seismicity, maximum seismogenic depth and threshold of surface faulting. The project site is in the southern Cascades source zone. Maximum earthquake magnitudes associated with crustal sources in the southern Cascades zone are Magnitude 5.5 (probability = 0.3), Magnitude 6.0 (probability = 0.6), and Magnitude 6.5 (probability = 0.1).

***Specific Faults:*** The following discrete faults or fault zones are classified in the ODOT Report as "probable Quaternary Age" or later faults and are located within about 25 miles of the site.

*Metolius Fault Zone* – The Metolius fault zone is comprised of several mostly southwest-dipping, northwest-trending normal faults that offset volcanic rocks and sediments along the eastern margin of the Cascade Range in central Oregon. The structural setting of the Metolius fault zone is open to interpretation, but the fault zone probably forms part of the eastern boundary of the Cascades graben in a structural transition zone at the northern end of the Brothers fault zone (USGS, 2020).



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This fault has three sections; the Green Ridge, the Rimrock-Tumalo, and the Northwest Rift zone sections. This fault zone portion nearest the site is comprised of relatively short individual faults extending from Awbrey Butte in Bend to Black Butte, near Sisters, Oregon. This fault is located approximately 14 miles to the west of the site. The length of this fault zone is approximately 60 miles and the widths vary from about 2 to 5 miles. The ODOT report has assigned a moderate probability of activity (0.7) to this group of faults. The slip rates for these faults range from 0.01-to-0.1 mm/yr. The highest probability is assigned to a slip rate of 0.05 mm/yr. (probability = 0.5). If an earthquake were to occur on this fault zone, its probable maximum magnitude is about 6.8 (U.S. Bureau of Reclamation, 1989). The most recent displacement age for normal faulting on the Metolius Fault Zone of the Rimrock-Tumalo Section, is thought to be less than 1.6 million years old (USGS, 2020).

*Sisters Fault Zone* – This fault zone is a prominent northwest-trending structure comprised of relatively short individual faults extending from Newberry Volcano to Black Butte, near Sisters, Oregon. This nearest segment of this fault zone is located approximately 8 miles west of the site. The length of this fault zone is approximately 60 miles and the widths vary from about 3.5 to 8 miles. There is no evidence of late Quaternary activity associated with these faults; however, the ODOT report assigns a moderate probability of activity (0.6). Potential rupture lengths range from 9 to 38 miles. The slip rates assigned to faults within this zone are 0.01 mm/yr. (probability = 0.3), 0.05 mm/yr. (probability = 0.5), and 0.1 mm/yr. (probability = 0.2). If an earthquake were to occur on this fault, its probable maximum magnitude is about 6.3.

## 5.2 EARTHQUAKE GROUND MOTIONS

### *5.2.1 Ground Response Spectra*

Local geologic deposits can significantly amplify the ground response and the response of structures (represented by a response spectrum) as earthquake motions are propagated from bedrock to the soil surface.

Based on the design finished floor elevation of the reservoir, and depth to bedrock, we anticipate the foundation elements will typically be underlain by less than 10 feet of soil. Based on the conditions encountered during our field exploration program, 2016 ASCE 7 Site Class B is recommended for use in design of the reservoir.

Based on the site's latitude, longitude, and subsurface conditions, site-specific response spectra were developed. The spectra shown in **Appendix C** includes the criteria for Site Class B from the 2019 OSSC, with a return interval of 2,500 years (approximately equivalent to a two percent



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probability of exceedance in 50 years). The resulting short period spectral response acceleration (0.2 second) for the site (Ss) is 0.357g, and the 1.0 second (S1) spectral response acceleration is 0.184g. This corresponds to Seismic Coefficient values of Fa = 1 and Fv = 1. The five percent damped design spectral response acceleration at short periods (SDS) is 0.238g, and the one-second period (SD1) is 0.123g.

### *5.2.2 Peak Ground Acceleration*

The peak ground accelerations developed in the ODOT report were estimated by combining the earthquake sources discussed above with published attenuation relationships (Sadigh et. al, 1993; Idriss, 1991; Boore et. al., 1993). Peak ground accelerations and spectral accelerations incorporated into the 2019 OSSC have been periodically modified based on more recent USGS studies.

Based on the ASCE Seismic Hazard Tool, utilizing 2016 ASCE 7 and seismic site class B, the risk-based peak ground acceleration recommended for this site is 0.162g.

## 5.3 SEISMIC HAZARDS SUMMARY

The OSSC specifically requires that certain geologic hazards be addressed in a site-specific seismic study. These are summarized in this section.

*Ground Motion*: Discussed in Section 5.2, Earthquake Ground Motions.

*Liquefaction/Settlement*: The potential for seismically-induced liquefaction to develop within the profile was evaluated using the procedure outlined by Youd et. al. (2001). The procedure uses standard penetration test (SPT) blow counts and other soil data to estimate the cyclic resistance ratio (CRR) profile with depth (ratio of the cyclic shear stress required to cause liquefaction to the initial vertical effective stress). The cyclic stress ratio (CSR) profile with depth (ratio of cyclic shear stress to initial vertical effective stress) resulting from the design level earthquake is estimated from the total and effective stresses, the peak ground surface acceleration value, the magnitude of the design level earthquake, and a depth dependent stress reduction factor.

Based on the results of our geotechnical exploration, and lack of loose, saturated soils, the liquefaction potential at the site is nil.



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*Landslide/Lateral Spreading*: There is a negligible risk from earthquake-induced landslides and lateral spreading due to the lack of significant slopes or potentially liquefiable zones.

*Fault Rupture*: The trace of the nearest mapped fault is associated with the Sisters Fault Zone and the Tumalo-Rimrock Fault Zone. These NW-SE trending normal faults are approximately 8 to 14 miles west of the project site. Based on our geologic research and local experience, the faults are reasonably mapped, and while in relatively close proximity to the project, it does not appear likely for fault rupture to occur at the proposed reservoir site.

*Tsunami or Seiche*: There is no risk, based on the inland location of the site and lack of significant bodies of water in the immediate vicinity of the project.



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## 6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of field exploration, laboratory testing, engineering analyses and our local experience, it is our opinion that the site is suitable for the proposed development from a geotechnical perspective, provided the recommendations presented in this report are incorporated into design and construction.

### 6.1 EXCAVATIONS AND GRADING

The primary geotechnical concern is the presence of existing undocumented fill that extends up to 4.5-feet bgs. Based on review of the concept plans and the subsurface findings of the geotechnical exploration, we anticipate cuts of up to approximately 4.5-feet will be required to remove undocumented fill materials. Due to the nature of the surrounding site operations, it is possible that additional areas of existing fill and refuse may be present throughout the site and may be deeper than encountered during the investigation. Cuts to remove the fill materials can generally be excavated with conventional earth-moving equipment such as excavators and small dozers. We anticipate that shallow basalt bedrock may be encountered when excavating for foundation elements such as footings or during construction of below-grade utilities. Competent basalt bedrock will require hydraulic-hammering or blasting to efficiently remove excess material.

Excavations made in fill materials should be classified as “Type C” material for OSHA excavation purposes. If sloping excavations are used in fill material or native soil, the temporary slopes should not be steeper than 1.5 to 1, horizontal to vertical (H to V). Permanent slopes should be at grades no steeper than 2 to 1 (H to V). Typically for permanent slopes, competent basalt may be cut at a slope not exceeding ½ to 1 (H to V). Basalt rock that is excessively disturbed by blasting may require classification as “Type B” material and would require slopes not exceeding 1 to 1 (H to V). We do not anticipate groundwater will be encountered during undocumented fill removal operations.

#### *6.1.1 Site Preparation*

All asphalt-pavement, concrete slab, abandoned utilities, refuse, and undocumented fill material should be removed within development areas. Development areas are considered the area extending to five feet beyond the building perimeters and areas with planned asphalt or concrete pavement. All fill material and deleterious material should be removed to expose native soil, or basalt bedrock. Once fill materials are removed the subgrade should be moisture-conditioned (excluding basalt bedrock) and compacted with suitable compaction equipment.



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Where shallow basalt bedrock is present at the bottom of footing elevations, we recommend over-excavation of 6-inches and replacement with compacted aggregate base course (ABC).

After removal of unsuitable materials as noted above, the subgrade should be proof-rolled with a loaded 10-cubic-yard dump truck, or full 4,000-gallon water truck, to confirm subgrade stability, where accessible. Any deflection observed during proof-roll observations should be addressed. If unstable ("pumping") soil is observed, remedial measures may consist of further compaction, including moisture-conditioning (aeration), or over-excavation and replacement with granular, structural fill. Pumping soil conditions are more common when site preparation occurs during spring and after periods of prolonged precipitation. Wallace Group should be consulted to observe proof rolls or to observe bottom of footing excavations to confirm subgrade bearing conditions prior to placing structural fill, concrete forms, or steel rebar.

### *6.1.2 Engineered Fill Materials and Placement*

Based on the FFEs provided by BLRB, dated October 19, 2020, we anticipate there could be up to approximately 15-feet of structural fill necessary to achieve design subgrade elevations below the footings and slabs.

Where engineered fill is needed to raise grades beneath load-bearing elements, such as below footings, slab-on-grade, or pavement, we recommend it consist of appropriately-graded sand and gravel having 100 percent passing a two-inch sieve, less than 30 percent retained on the ¾-inch sieve, less than 20 percent passing a No. 200 sieve, and have a maximum dry unit weight of at least 90 pounds per cubic foot (pcf). On-site native soil and rock should be suitable for re-use as structural fill with sufficient processing, provided it meets the specifications in **Table 6.1.2**.

Engineered fill and aggregate base course (ABC) placed below footings or slabs should be placed in eight-inch lifts, loose thickness or less, and compacted to at least 95 percent of modified Proctor (ASTM D1557). All structural fill exceeding 5 feet vertical should be compacted to at least 95 percent of ASTM D1557. Fill within landscaped areas typically does not require compaction; however, if the fill depth exceeds four feet, we recommend compaction to a minimum of 85 percent of ASTM D1557 to limit potential settlement.



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In addition, we recommend:

- Engineered fill be moisture-conditioned to within a range of +/-2 percent of optimum moisture content, placed in lifts, and compacted as recommended in **Table 6.1.2**, *Engineered Fill Specifications Summary;*
- We recommend structural fill have a maximum dry density (ASTM D1557) of at least 90 pounds per cubic foot (pcf);
- Fill should be placed in level lifts and should be benched and keyed into slopes;
- Engineered fill should not be placed during freezing weather or on frozen subgrade to avoid potential thaw settlement; and
- Wallace Group should periodically observe the fill placement and test the fill for grain-size and compaction.

**Table 6.1.2** summarizes the grading and placement specifications for anticipated uses of engineered fill for this project.



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**Table 6.1.2**
**Engineered Fill Specifications Summary**

| Material Type & Specifications | Placement Location | Placement Specifications |
|---|---|---|
| *Base Course* – Crushed Aggregate, ¾-inch minus, <8% passing #200 sieve | Base Course Beneath Slabs on Grade, Pavement, and Footings | Maximum 6" lifts; compacted to minimum 95% of modified Proctor density (ASTM D1557) |
| *Engineered Fill* - Granular, Inorganic soil, 2-inch minus, <30% retained on ¾-inch sieve, <20% passing #200 sieve. Non-plastic. Maximum dry density of at least 90 pcf. | Beneath Slabs on Grade, Exterior Slabs, Sidewalks, Pavement, Foundation Backfill, and Retaining Wall Backfill | Maximum 8" lifts; compacted to minimum 95% of modified Proctor density (ASTM D1557) beneath buildings and pavement, all fill exceeding 5 feet vertical, 92% for exterior sidewalks |
| *Utility Trench and General Backfill* – 2-inch minus sand & gravel, <20% passing the No. 200 sieve, or on-site soil materials | Utility Trench Backfill | Maximum 8" lifts; compacted to minimum 95% of modified Proctor density (ASTM D1557) beneath footings, floor slabs, 92% for exterior concrete asphalt pavement, and sidewalks, 90% in non-structural areas |
| *Granular Landscape Fill* – Inorganic soil, 3-inch minus | Landscaped Areas | Fill depth less than 4 feet, compaction not required. Fill depths greater than 4 feet, compact to a minimum of 85% of ASTM D1557 |
| *Drainage Fill* – 2-inch minus sand and gravel, either crushed or pit-run, <3% passing a No. 200 sieve | Retaining Wall Drainage | Minimum 92 percent of ASTM D1557, for footings, slabs, and pavement, 85% for non-structural backfill. |



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## 6.2 FOUNDATIONS

Based on subsurface conditions in areas that were explored we anticipate that the most economical foundation system for the structures will be conventional, shallow cast-in-place spread footings. We anticipate footings will bear on a combination of compacted native soil, compacted structural fill, and a thin section of ABC where shallow basalt is present. Footing excavations should be visually observed by Wallace Group prior to placing ABC, concrete forms, or steel rebar. Footings bearing on compacted native soil, structural fill, and basalt bedrock can be designed for a maximum allowable bearing pressure of 2,500 pounds per square foot (psf). The maximum allowable bearing pressure is a function of tolerance for settlement and subgrade bearing conditions. If building or the water tank locations are moved or if finished floor elevations change, Wallace Group should confirm that the bearing capacity recommendations are appropriate.

If the design team prefers higher bearing capacity and reduced settlement, we recommend spread footings are deepened to bear on basalt bedrock. The maximum allowable bearing pressure can be increased to 4,500 psf where footings bear on competent basalt bedrock with a compacted ABC leveling course.

Any engineered fill placement in the development area should be observed and tested on a part-time basis by Wallace Group geotechnical personnel. After excavating for individual strip and pad footings, bearing surfaces should be compacted with suitable equipment, such as hoe-packs or jumping jacks to densify any loose or disturbed material.

The following recommendations should be incorporated into project plans and specifications:

- Exterior footings should bear below frost depth. A minimum foundation burial depth of 18 inches is required for frost protection.
- Continuous strip footings should be at least 12 inches wide. Isolated pad footings should be at least 18 inches square.
- On a preliminary basis, we conclude that footings bearing on properly compacted native soil, structural fill, and ABC will experience total and differential static settlement less than ¾-inch. Wallace Group should be consulted to confirm the settlement estimates after footing sizes and column loads are finalized.
- Structural fill placed beneath footings should be compacted to 95 percent of modified Proctor density, ASTM D1557.
- The allowable bearing pressure can be increased by 1/3 for temporary loads such as wind and seismic.



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- Wallace Group should confirm foundation excavations are firm and free of loose or weathered material prior to placing ABC and reinforcement.
- The ultimate coefficient of sliding resistance between the concrete and bearing materials is 0.52. A factor of safety against sliding greater than 1.5 is considered acceptable if passive resistance is ignored. If passive resistance is included in sliding resistance, a factor of safety at least 2.0 should be used.

### 6.3 LATERAL EARTH PRESSURES

Lateral pressures on earth retaining walls will depend on the type of wall, hydrostatic pressure behind the wall, type of backfill material, and allowable wall movement. Where allowable wall movement is less than approximately ½-percent of the wall height or where wall movement is constrained, lateral earth pressures should be estimated for an "at rest" condition. In general, walls that are attached to a structure should be designed for the "at rest" condition and unattached walls may be designed for the "active" condition.

Walls backfilled with on-site silty-sand material or similar import should be designed for an equivalent fluid lateral earth pressure of 55 pcf for the "at rest" condition and 35 pcf for the "active" condition. A seismic surcharge of 20 pcf should be included in design. If vehicular traffic is expected within a lateral distance equal to the height of the wall, a vehicular surcharge value of 100 psf should be included. If large equipment or vehicles is expected near retaining walls, we should confirm the surcharge value is appropriate. We recommend an ultimate coefficient of sliding resistance between the concrete and bearing materials of 0.52 be used in the analysis. A factor of safety against sliding of 1.5 should be applied when calculating sliding only; however, we recommend a minimum factor of safety of 2.0 is applied if relying on both sliding and passive resistance.

Below grade walls should be waterproofed to protect against moisture migration. The waterproofing should be placed directly against the backside of the walls. We recommend below-grade walls have back-drains to prevent the buildup of hydrostatic forces. The back-drain should consist of a perforated pipe encased in drain rock and covered in filter fabric. The gravel drain should be at least 12 inches wide and should extend up the back of the wall to about 2 feet below the ground surface; the upper 2 feet should be covered with soil to reduce infiltration of surface water. The back-drain pipe should have a minimum uniform slope of at least 1/16-inch per foot. We recommend that the pipe is placed outside of the footing exterior. It should extend to a suitable, gravity drainage disposal location downslope. The drainpipe should consist of rigid four-inch diameter perforated PVC pipe placed in a bedding of, and



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surrounded by, standard 2-inch, washed drain rock. The annular thickness of drain rock around the pipe should be at least four inches. The drain rock should be encased in filter fabric to reduce the potential for migration of fine soil particles into and clogging the pipe. We recommend that the foundation drain be constructed with cleanouts to allow access to clear the pipe, if needed.

### 6.4 FLOOR SLABS AND EXTERIOR FLATWORK

Compacted native soil and structural fill will be exposed at slab subgrade level for interior slabs-on-grade and exterior flatwork. The compacted native soil and structural fill will provide adequate support for the interior floor slabs and exterior concrete flat work, if they are placed, compacted, and prepared in accordance with **Section 6.1.1 – *Site Preparation***.

Light-duty concrete flatwork, such as sidewalks, should be underlain by a minimum of four inches of compacted ABC. The base course below exterior flatwork should meet the specifications shown in **Table 6.1.2**, ***Engineered Fill Specifications Summary***. Structural fill beneath sidewalks should be placed in lifts not exceeding eight inches thick and compacted to 92 percent of modified Proctor density. All organic material, including roots larger than half-inch in diameter, and other deleterious material exposed at sidewalk subgrade elevations should be removed to expose firm, unyielding native soil and replaced with structural fill.

We recommend a minimum of 8 inches of crushed ABC be placed beneath the interior slab-on-grade. The base course should comply with the specifications shown in **Table 6.1.2**, Engineered Fill Specifications Summary, and be compacted to at least 95 percent of ASTM D1557. If more than six inches of material is needed to establish bottom-of-slab level, either additional base course or structural fill, compacted to a minimum of 95 percent of ASTM D1557, can be used to raise the subgrade level. For interior slab design we recommend the modulus of subgrade reaction (k) be 150 pounds per cubic inch (pci).

The groundwater table in the project area is approximately 350 feet bgs, so placement of a vapor retarder beneath slab-on-grade floors does appear warranted for this site. If a vapor retarder is used, the current industry standard is to place a vapor retarder on top of the crushed rock layer. A vapor retarder may be warranted if moisture sensitive flooring or equipment are expected.

The native soil exhibits low to moderate frost heave potential in its present moisture condition. However, if a source of moisture becomes present, the soil will exhibit some frost heave.



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Exterior slabs could heave on the order of ½-inch if the silty-sand subgrade soil were saturated and sub-zero temperatures occurred. Exterior slabs should be depressed from doorway thresholds ½-inch to accommodate frost heave. The most effective and economical method to control frost heave is provision for adequate drainage of surface runoff away from slabs and other foundation elements.

## 6.5 DRAINAGE CONSIDERATIONS

Foundation and slab performance are influenced by drainage conditions around the perimeter of the structures. Adequate drainage should be provided and maintained throughout the life of the structures and water must not be allowed to infiltrate to the foundation level. We recommend the ground surface be sloped to drain surface water away from the structures without ponding. The ground surface adjacent to foundations should be sloped away from foundations at least 5 percent in landscaped areas and 2 percent in hard-surfaced areas.

## 6.6 PAVEMENT RECOMMENDATIONS

### *6.6.1 Parking Areas and Access Drives*

We anticipate that traffic will likely consist of light automotive and service vehicles. Traffic during construction will consist of heavier vehicles with higher wheel loads and precautions should be taken to prevent damage to any newly constructed pavement.

The proof-rolled, inorganic native granular soil, and properly compacted new structural fill will provide, in our opinion, adequate subgrade support for asphalt-paved roadways associated with the development. Proper roadway section drainage, including site drainage to avoid ponding of water adjacent to roadway areas, will aid in reducing the potential for pavement distress. Structural fill in paved areas should consist of processed on-site native soil `or imported sand and gravel meeting the requirements of **Table 6.1.2**, Engineered Fill Specifications Summary. Roadway subgrade fill should be placed in maximum 8-inch lifts, loose thickness, moisture-conditioned, and compacted to at least 92 percent of ASTM D1557.

Based on the project soil conditions and assumed traffic loads for asphalt-paved parking and access drives, we recommend a pavement section of 4-inches of hot mix asphalt concrete (HMAC) underlain by 8-inches of crushed ABC. Concrete pavement, if constructed, should consist of a minimum of 6-inches of concrete underlain by 10-inches of ABC. Concrete pavement is recommended for areas with heavy anticipated wheel loads.



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### *6.6.2 Pavement Material Specifications*

The AC should be dense-graded, hot mix asphalt concrete (HMAC) as specified in ODOT Section 00745 plus the following supplemental specifications for density testing:

- The HMAC mix design for the roadways should be Level 2.
- The asphalt binder should be PG 64-28, or as specified by the Civil Engineer.
- The ABC should be ¾-inch minus, dense graded aggregate as specified in ODOT Sections 00641 and 02630.10.
- Road-mixed ABC is permitted per Section 00641. Road-mixed ABC allows water to be added on-site for compaction vs. pug-milled materials processing.
- The HMAC should be compacted to a minimum of 92 percent of the Rice theoretical maximum density. The ABC should be compacted to a minimum of 92 percent of ASTM D1557.

*Supplemental Specifications for Density Testing:* The roadway AC and ABC should be field tested for in-place density. Density test frequency should be based on a "roll-pattern" or Standard City of Redmond procedures.



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# 7.0 ADDITIONAL SERVICES

## 7.1 FINAL DESIGN AND CONSTRUCTION PERIOD ENGINEERING SERVICES

Wallace Group will review the geotechnical and civil aspects of the project design plans and specifications, when completed, to confirm that our recommendations are incorporated into the project documents, and to make appropriate modifications, if necessary. We currently anticipate performing design review of foundation, grading, and drainage plans to document that our recommendations are incorporated into design. This review will reduce misinterpretation of our recommendations and reduce the potential for costly design changes and construction delays.

## 7.2 CONSTRUCTION INSPECTION AND TESTING

To maintain our role as the Engineer-of-Record for the project, Wallace Group should observe and monitor earthwork construction including site preparation, excavations, placement and compaction of engineered fill, utility trench backfills, foundation and slab preparation. The purpose of these services will be to help document that site grading and foundation preparation are constructed in conformance with the recommendations of this geotechnical report and the approved project plans and specifications. If subsurface conditions are encountered during construction that differs from the conditions described herein, we will review our recommendations considering these different conditions and recommend appropriate changes in design or construction procedures.

To help assure the proposed development is constructed in accordance with approved project plans, specifications, and building code requirements, Wallace Group can also represent the owner during construction and provide comprehensive special inspection and construction materials testing services in accordance with IBC and City of Redmond Building Department requirements. Wallace Group personnel specialize in construction monitoring, testing and inspection and we look forward to preparing a scope of work and budget for these services upon completion of the project plans and specifications, and establishment of a construction schedule.



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## 8.0 LIMITATIONS

Exploratory borings and test pits performed for this study were placed to obtain a representative picture of underground conditions for evaluation and preliminary design purposes. The study was performed using a mutually-agreed-upon scope of services. Variations from these conditions, not indicated by the borings are possible. These variations are sometimes enough to necessitate design modifications. Civil & Environmental Consultants, Inc. (Client) must recognize that it is impossible to predict every physical condition that will be encountered. If unexpected conditions are observed during construction, we should be notified to review the recommendations contained in this report. The professional judgments expressed in this report meet the standard of care of our profession; however, no warranty is expressed or implied.

If building or water tank locations or finished floor elevations change, Wallace Group should confirm the recommendations contained herein after development plans are available. This report may be used only by the Client and only for the purposes stated within a reasonable time from its issuance, but in no event, later than three (3) years from the date of the report. Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required with the passage of time. Any party other than the Client or their design team who wishes to use this report shall notify the Wallace Group of such intended use. Based on the intended use of the report, the Wallace Group may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release Wallace Group from any liability resulting from the use of this report by any unauthorized party.

The contractor selected for this project is responsible for supervision and direction of the actual work performed by his employees, subcontractors, and agents. Wallace Group will use accepted geotechnical engineering and testing procedures; however, our testing and observations will not relieve the contractor of his primary responsibility to produce a completed project conforming to the project plans and specifications.

This firm does not practice or consult in the field of safety engineering. We do not direct the contractor's operations, and we cannot be responsible for the safety of personnel other than our own on the site. The safety of others is the responsibility of the contractor. The contractor should notify the owner if he considers any of the recommended actions presented herein unsafe.



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## 9.0 REFERENCES

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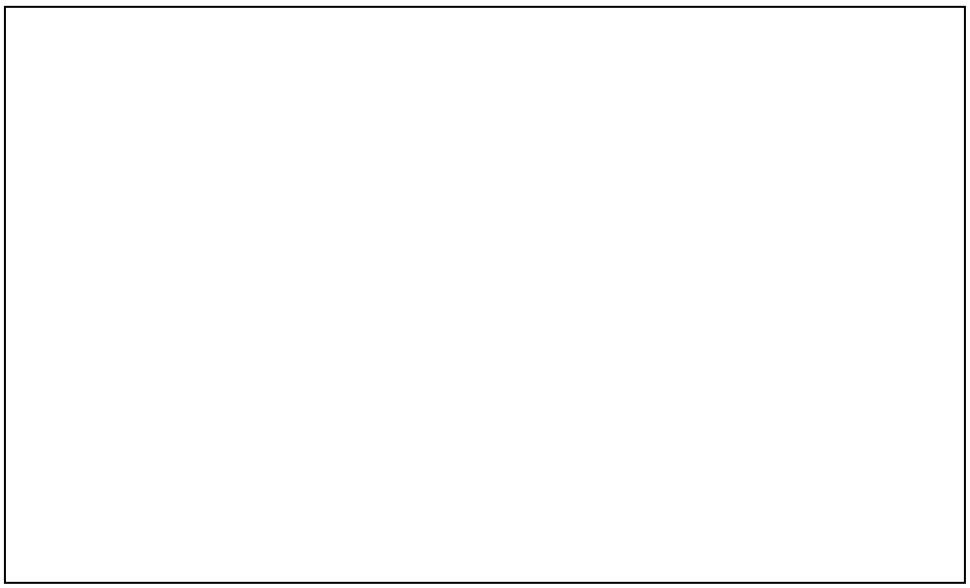
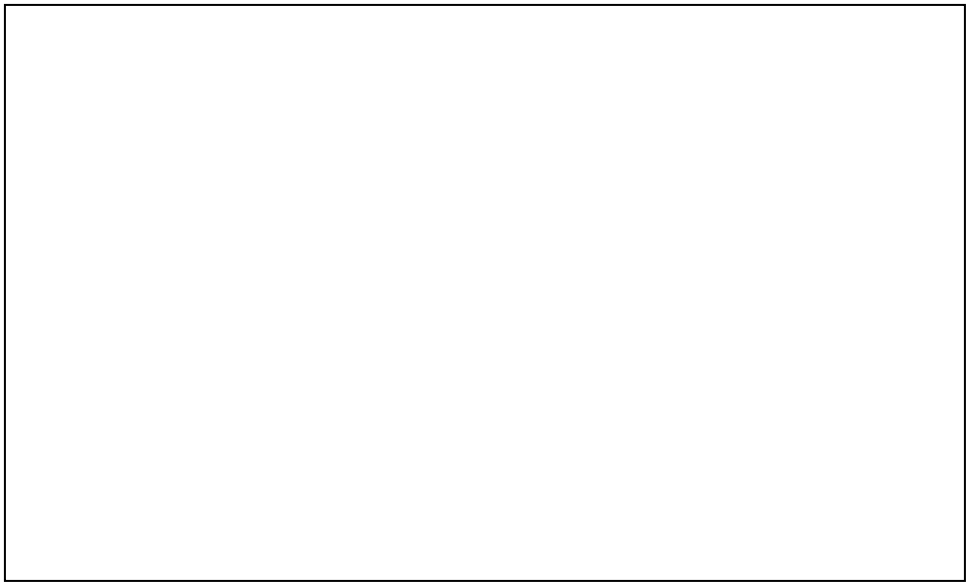
## 10.0 PROFESSIONAL AUTHENTICITY

This report has been authored and reviewed by the undersigned, respectively. This report is void if the original seal(s) and signature(s) are not included.



Adam Larson, P.E.
Staff Geotechnical Engineer



Lisa Splitter, P.E., G.E.
Senior Geotechnical Engineer



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# FIGURES




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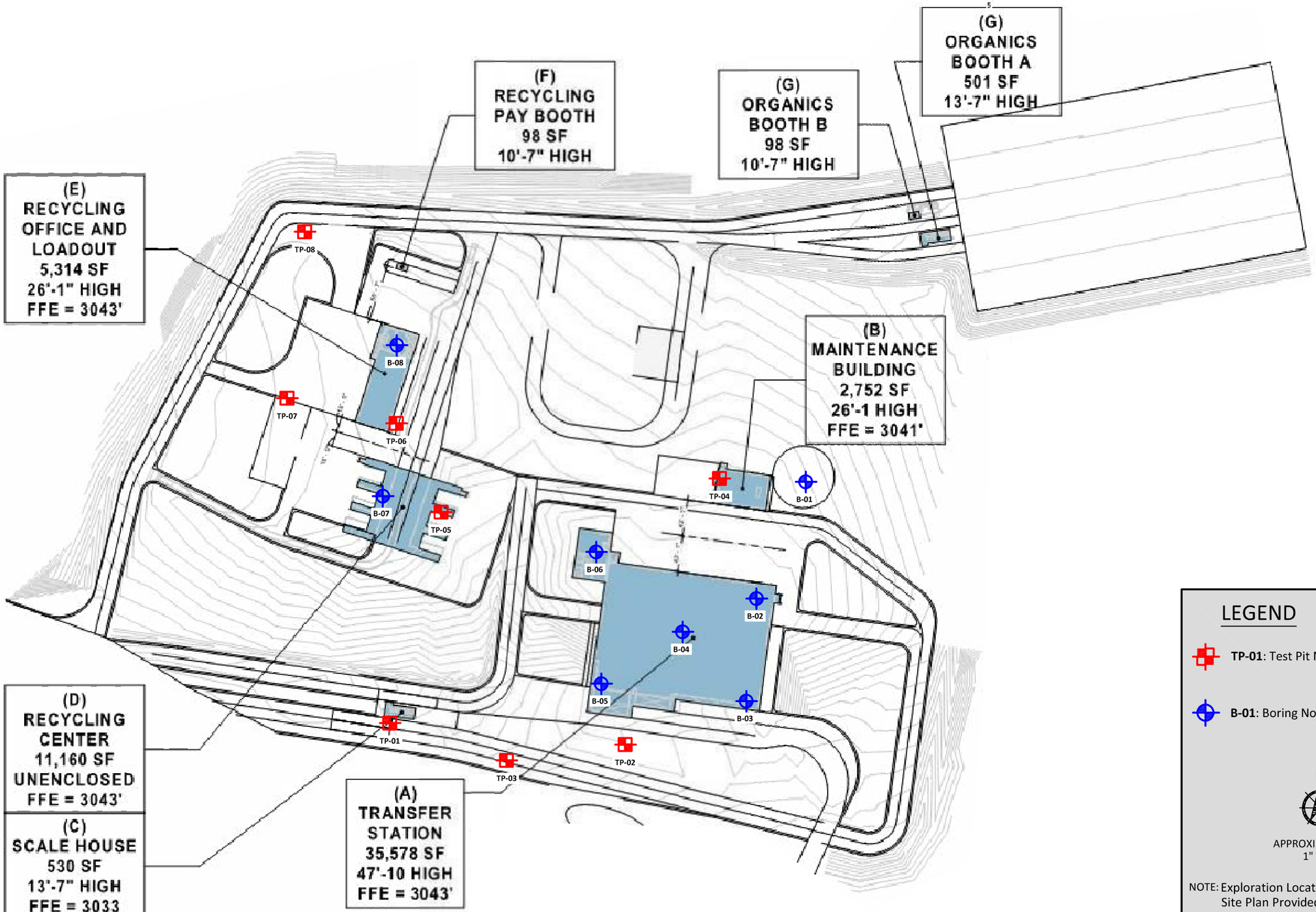
**VICINITY MAP**
**NEGUS RECYCLING & TRANSFER FACILITY**
**2400 NE MAPLE WAY**
**REDMOND, OREGON**

| | |
|---|---|
| PROJECT No: | 11301 (1) |
| DRAWN: | July 23, 2020 |
| DRAWN BY: | KAK |
| CHECKED BY: | AML |
| FILE NAME: | 11301 (1) Figure 1 |

FIGURE
1




## LEGEND

**TP-01**: Test Pit No. and Location

**B-01**: Boring No. and Location

N

APPROXIMATE SCALE
1" = 125'

NOTE: Exploration Locations are Approximate
Site Plan Provided By BLRB



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# EXPLORATION LOCATION MAP
# NEGUS RECYCLING & TRANSFER FACILITY
# 2400 NE MAPLE WAY
# REDMOND, OREGON

| | |
|---|---|
| PROJECT No: | 11301 (1) |
| DRAWN: | October 20, 2020 |
| DRAWN BY: | KAK |
| CHECKED BY: | AML |
| FILE NAME: | 11301 (1) Figure 2 |

FIGURE: 2

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# APPENDIX A

## APPENDIX A
## FIELD EXPLORATION SUMMARY

### GENERAL

Subsurface conditions for the proposed Negus Recycling & Transfer Facility project located in Redmond, Oregon, were explored by advancing 8 geotechnical borings (designated B-01 through B-08) and excavating 8 test pits (designated TP-01 through TP-08), at the approximate locations shown on **Figure 2**, Exploration Location Map. Boring and test pit logs are included in this appendix. The boring and test pit explorations were performed between July 20 and 22, 2020. The procedures used to advance the borings, excavate the test pits, and collect soil samples and other field techniques are described in detail in this appendix. Unless otherwise noted, all soil sampling and classification procedures followed local engineering practices which are in general conformance with relevant ASTM procedures and the Unified Soil Classification System (USCS). "General conformance" means that certain local and common excavation and descriptive practices and methodologies have been followed.

### BORINGS

Eight (8) borings were drilled within the development area by Western States Soil Conservation of Hubbard, Oregon. The borings were drilled to depths of approximately 25 feet below ground surface (bgs) with a Central Mining Equipment (CME) 75 truck-mounted drilling rig. Borings were advanced using hollow stem auger and HQ-wireline core drilling techniques. Borings were abandoned in accordance with Oregon Water Resources Department requirements by backfilling the borehole with bentonite.

Drilling activities were observed by a Wallace Group geotechnical professional who maintained a detailed log of subsurface conditions and materials encountered and documented the abandonment of each boring.

### TEST PITS

Eight (8) test pits were excavated with a Takeuchi mini-excavator operated by Terry Shine Excavation of Bend, Oregon. The excavator bucket was 30 inches wide and equipped with conventional spade teeth. The test pits were observed by a Wallace Group geotechnical professional who maintained a detailed log of subsurface conditions and materials encountered, collected soil samples, and documented backfilling. The test pits were excavated to depths ranging between ½ to 4½ feet below ground surface (bgs). Bulk samples were retrieved for laboratory testing. Test pit locations should be re-excavated during construction and backfilled in accordance with **Section 6.1.2**-Structural Fill Materials and Placement.

Dynamic Cone Penetration (DCP) testing was conducted to evaluate the relative density of the soil. DCP procedures are generally described in ASTM Special Technical Publication 399, which have been modified by Wallace Group to provide better representation of soil relative density or stiffness. During the DCP test, a 1.5-inch diameter steel cone is driven up to 18 inches into the soil using a 15-pound hammer dropped from a height of 18 inches. The number of blows is recorded and can be roughly correlated to the Standard Penetration Test. The number of blows required to drive the cone 12 inches into the soil provides a measure of the relative density of granular soils such as sand and gravel, and the strength of cohesive soils.

**SAMPLING**

Disturbed soil samples were retrieved from the SPT sampler and the test pits. The samples were classified and sealed in plastic bags for further examination and physical testing in our laboratory for gradation, and moisture content.

**TEST PIT AND BORING LOGS**

Borings: Figure A is a Legend explaining the information and symbols presented on the boring logs. The logs of the borings are presented on Figures A-1 through A-8. The logs describe the materials encountered and the depths where materials and/or characteristics of these materials changed, although the changes may be gradual. Where material types and descriptions changed between samples, the contacts were interpreted. On each boring log, the types of samples collected (including their identification number) are reported, including laboratory test results, and SPT blow counts. Corrected SPT blow counts, presented on the boring logs, have been corrected for sampling type and hammer energy. Elevations on borings logs are approximate and should be confirmed with survey methods.

Test Pits: The logs of the test pits are presented on Figures A-9 through A-16. The logs describe the materials encountered and the depths where materials and/or characteristics of these materials changed, although the changes may be gradual. Where material types and descriptions changed between samples, the contacts were interpreted. On each test pit, the types of samples collected (including their identification number) are reported, including laboratory test results and DCP blow counts.

**MATERIAL DESCRIPTIONS**

Soil samples were visually classified in the field as they were collected. Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the samples were noted. Afterwards, the samples were re-examined in the laboratory, various standard

classification tests were conducted, and the field classifications were modified where necessary. The terminology used in the soil classifications and rock descriptions are defined beginning on Page 4 and are included under material description on each log.

**GROUNDWATER**

Groundwater was not encountered during subsurface exploration for this project.

## TERMINOLOGY USED TO DESCRIBE SOIL AND ROCK DESCRIPTIONS

Soils exist in mixtures with varying proportions of components. The predominant soil, i.e., greater than 50 percent based upon total dry weight, is the primary soil type and is capitalized in our log descriptions, e.g., SAND, GRAVEL, SILT or CLAY. Lesser percentages of other constituents in the soil mixture are indicated by use of modifier words in general accordance with the Visual-Manual Procedure (ASTM D2488-93). "General Accordance" means that certain local and common descriptive practices have been followed. In accordance with ASTM D2488, group symbols (such as GP or CH) are applied on that portion of the soil passing the 3-inch (75mm) sieve based upon visual examination. The following describes the use of soil names and modifying terms used to describe fine- and coarse-grained soils.

**FINE - GRAINED SOILS (MORE THAN 50% FINES PASSING 0.074 MM, #200 SIEVE)**

The primary soil type i.e. SILT or CLAY is designated through visual – manual procedures to evaluate soil toughness, dilatancy, dry strength, and plasticity. The following describes the terminology used to describe fine - grained soils and varies from ASTM 2488 terminology in the use of some common terms.

| Primary soil NAME, adjective and symbols | | | Plasticity Description | Plasticity Index (PI) |
|---|---|---|---|---|
| | | ORGANIC | | |
| SILT | CLAY | SILT & CLAY | | |
| ML & MH | CL & CH | OL & OH | | |
| SILT | | Organic SILT | Non-plastic | 0 - 3 |
| SILT | | Organic SILT | Low plasticity | 4 - 10 |
| Clayey SILT | Silty CLAY | Organic clayey SILT | Medium Plasticity | >10 – 20 |
| Clayey SILT | CLAY | Organic silty CLAY | High Plasticity | >20 – 40 |
| Clayey SILT | CLAY | Organic CLAY | Very Plastic | >40 |

Modifying terms describing secondary constituents, estimated to 5 percent increments, are applied as follows:

| Description | % Composition |
|---|---|
| **Trace sand, trace gravel** | 5% - 10% |
| **With sand; with gravel** | 15% - 25% |
| **Sandy, or gravelly** | 30% - 45% |

**Borderline Symbols**, for example CH/MH, are used where soils are not distinctly in one category or where variable soil units contain more than one soil type. **Dual Symbols,** for example CL-ML, are used where two symbols are required in accordance with ASTM D2488.

**Soil Consistency.** Consistency terms are applied to fine-grained, plastic soils (i.e., PI $\geq$ 4). Descriptive terms are based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84, as follows.

| Consistency Term | SPT N-value | Unconfined Compressive Strength | |
|---|---|---|---|
| | | Tons/sq.ft. | kPa |
| **Very soft** | Less than 2 | Less than 0.25 | Less than 24 |
| **Soft** | 2 - 4 | 0.25 - 0.5 | 24 - 48 |
| **Medium stiff** | 5 - 8 | 0.5 - 1.0 | 48 – 96 |
| **Stiff** | 9 - 15 | 1.0 - 2.0 | 96 – 192 |
| **Very stiff** | 16 - 30 | 2.0 - 4.0 | 192 – 383 |
| **Hard** | Over 30 | Over 4.0 | Over 383 |

Note: For SILT with low to non-plastic behavior, (i.e., PI < 4) a relative density description is applied.

***Coarse-Grained Soils (less than 50% fines)***

Coarse-grained soil descriptions, i.e., SAND or GRAVEL, are based on that portion of materials passing a 3-inch (75mm) sieve. Coarse-grained soil group symbols are applied in accordance with ASTM D2488 based upon the degree of grading, or distribution of grain sizes of the soil. For example, well graded sand containing a wide range of grain sizes is designated SW; poorly graded gravel, GP, contains high percentages of only certain grain sizes. Terms applied to grain sizes follow.

| | Particle Diameter | |
|---|---|---|
| | **Inches** | **Millimeters** |
| **Sand (S)** | 0.003 - 0.19 | 0.075 - 4.8 |
| **Gravel (G)** | 0.19 - 3.0 | 4.8 - 75 |
| | ***Additional Constituents*** | |
| **Cobble** | 3.0 - 12 | 75 - 300 |
| **Boulder** | 12 - 120 | 300 - 3050 |
| **Rock Block** | >120 | >3050 |

The primary soil type is capitalized, and the amount of 'fines' in the soil are described as indicated by the following examples. Other soil mixtures will provide similar descriptive names.

***Example: Coarse-Grained Soil Descriptions with Fines***

| **5% fines** | 10% fines **(Dual Symbols)** | 15% to 45% fines |
|---|---|---|
| GRAVEL with trace silt: GW or GP | GRAVEL with silt, GW-GM | Silty GRAVEL: GM |
| SAND with trace clay: SW or SP | SAND with clay, SP-SC | Silty SAND: SM |

Additional descriptive terminology applied to coarse-grained soils follow.

**Coarse-Grained Soil Containing Secondary Constituents**

| | |
|---|---|
| **Clean** | < 5% fines |
| **With sand or with gravel** | 15% - 25% sand or gravel |
| **Sandy or gravelly** | 30% - 45% sand or gravel |
| **With cobbles; with boulders** | Any amount cobbles or boulders. Additional terms may be used to describe amount including abundant, scattered. |

Cobble and boulder deposits may include a description of the matrix soils, as defined above.

**Relative Density** terms are applied to granular, non-plastic soils based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586.

| Relative Density Term | *SPT N-value* |
|---|---|
| **Very loose** | 0 - 4 |
| **Loose** | 4 - 10 |
| **Medium dense** | 10 - 30 |
| **Dense** | 30 - 50 |
| **Very dense** | > 50 |

## Terminology Used to Describe Rock

***Scale of Rock Strength***

| Description | Designation | Unconfined Compressive Strength, psi | Unconfined Compressive Strength, MP | Field Identification |
|---|---|---|---|---|
| Very low strength | R1 | 100 – 1000 | 0.7 – 7 | Crumbles under firm blows with point of geology pick; can be peeled by a pocketknife. |
| Low strength | R2 | 1,000 – 4,000 | 7 – 28 | Can be peeled by a pocketknife with difficulty; shallow indentation made by firm blows of geology pick. |
| Moderate strength | R3 | 4,000 – 8,000 | 28 – 55 | Cannot by scraped or peeled with a pocketknife; specimen can be fractured with a single firm blow of geology hammer. |
| Medium high strength | R4 | 8,000 – 16,000 | 55 – 110 | Specimen requires more than one blow with a geology hammer to fracture it. |
| High strength | R5 | 16,000 – 32,000 | 110 – 120 | Specimen requires many blows of geology hammer to fracture it. |
| Very high strength | R6 | > 32,000 | > 220 | Specimen can only be chipped with geology pick. |

**Descriptive Terminology for Joint Spacing or Bedding**

| *Descriptive Term* | *Spacing of Joints* | |
|---|---|---|
| Very close | Less than 2 inches | < 50 mm |
| Close | 2 inches - 1 foot | 50 mm – 300 mm |
| Moderately close | 1 foot - 3 feet | 300 mm – 1 m |
| Wide | 3 feet -10 feet | 1 m – 3 m |
| Very wide | Greater than 10 feet | > 3 m |

**Descriptive Terminology for Vesicularity**

| Descriptive Term | *Percent voids by volume* |
|---|---|
| Dense | < 1% |
| Slightly vesicular | 1 – 10% |
| Moderately vesicular | 10 – 30% |
| Highly vesicular | 30 – 50% |
| Scoriaceous | > 50% |

***Correlation of RQD and Rock Quality***

| Rock Quality Descriptor | RQD Value |
|---|---|
| Very poor | 0 – 25 |
| Poor | 25 - 50 |
| Fair | 50 - 75 |
| Good | 75 - 90 |

***Scale of Rock Weathering***

| *Stage* | *Description* | *Quality Distinction* |
|---|---|---|
| **Fresh** | Rock is fresh, crystals are bright, a few joints may show slight staining because of ground water. | Discoloration |
| **Very Slight** | Rock is generally fresh, joints are stained, some joints may have thin clay coatings, crystals in broken faces show bright. | Discoloration only on major discontinuity surfaces [i] |
| **Slight** | Rock is generally fresh, joints are stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some feldspar crystals are dull and discolored. Rocks ring under hammer if crystalline. | Discoloration on all discontinuity surfaces and on rock |
| **Moderate** | Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some are clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock. | Decomposition and/or disintegration < 50% of rock [ii] |
| **Moderately Severe** | All rock, except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick. Rock goes "clunk" when struck. | Decomposition and/or disintegration > 50%, but not complete |
| **Severe** | All rock, except quartz, discolored or stained. Rock "fabric" is clear and evident but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of harder rock usually left, such as corestones in basalt. | Decomposition and/or disintegration > 75%, nearly complete |
| **Very Severe** | All rock, except quartz, discolored or stained. Rock "fabric" is discernible, but mass effectively reduced to "soil" with only fragments of harder rock remaining. | Decomposition and/or disintegration 100% with structure/fabric intact |

| | | |
|---|---|---|
| **Complete** | Rock is reduced to “soil”. Rock “fabric” is not discernible, or only in small, scattered locations. Quartz may be present as dikes or stringers. | Decomposition and/or disintegration 100% with structure/fabric destroyed |

NOTES:
[i] Discontinuities consist of any natural break (joint, fracture or fault) or plane of weakness (shear or gouge zone, bedding plane) in a rock mass

[ii] Decomposition refers to chemical alteration of mineral grains; disintegration refers to mechanical breakdown

[iii] Stage and description from ASCE Manual No. 56 (1976), quality distinction from Murray (1981)

# KEY TO SYMBOLS

The Wallace Group
62915 NE 18th Street, Suite 1
Bend, OR 97701
(541) 382-4707

**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR

## LITHOLOGIC SYMBOLS
## (Unified Soil Classification System)

- BASALT: Basalt
- FILL: Fill (artificial fill)
- SM: USCS Silty Sand
- SP-SM: USCS Poorly-graded Sand with Silt

## SAMPLER SYMBOLS

- Continuous Sample
- Rock Core (RC)
- Standard Penetration Test

## WELL CONSTRUCTION SYMBOLS

## ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
FINES - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)
OC - ORGANIC CONTENT (%)

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UCCS - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION
Water Level at Time of Drilling, or as Shown
Water Level at End of Drilling, or as Shown
Water Level After 24 Hours, or as Shown



Figure: A

The Wallace Group
62915 NE 18th Street, Suite 1
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(541) 382-4707

# BORING NUMBER B-01



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3028 ft
**DRILLING CONTRACTOR** Western States Soil Conservation Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger & HQ-Wireline Coring
**AT TIME OF DRILLING** ---
**LOGGED BY** KAK **CHECKED BY** AML
**24HRS AFTER DRILLING** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS | Corrected N-Value | TESTS AND REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SILTY SAND, medium dense to dense, brown to tan, fine to coarse grained, subangular to subrounded, native | |
| 5 | SPT S-1 | 100 | 24 13 13 | 31 | Fines: 12.6 MC: 21.6 | SM | | | |
| 9.0 | | | | | | | | | 3019.0 |
| 10 | RC C-1 | 100 (65) | | | | | | BASALT, unweathered to slightly weathered, gray with red hue, vesicular, 1/16"- 1" vesicles, porphritic aphanitic, R3 to R4 | |
| 15 | RC C-2 | 100 (70) | | | Rubblized and fractured zone 18' bgs | | | | |
| 20 | RC C-3 | 100 (87) | | | | | | | |
| 25 | | | | | | | | | |
| 25.0 | | | | | | | | | 3003.0 |

Bottom of borehole at 25.0 feet.

TWG-BORING LOGS - WALLACE GROUP DATA TEMPLATE.GDT - 8/24/20 12:51 - L:\GINT PRO - FILES\BENTLEY\GINT\PROJECTS\11301-1 NEGUS RECYCLING & TRANSFER FACILITY BORINGS.GPJ

Figure: A - 1

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# BORING NUMBER B-02



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/20/20 **COMPLETED** 7/20/20
**GROUND ELEVATION** 3029 ft
**DRILLING CONTRACTOR** Western States Soil Conservation Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** KAK **CHECKED BY** AML
**24HRS AFTER DRILLING** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS | Corrected N-Value | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | |
| | SPT S-1 | 100 | 16 29 38 | 80 | SM | | SILTY SAND, very dense, brown to tan, fine to coarse grained, subangular to subrounded, pumiceous | |
| 4.0 | | | | | | | | 3025.0 |
| 5 | | | | | SM | | SILTY SAND WITH GRAVEL, brown to tan, fine to coarse grained, subangular to subrounded | |
| 5.0 | | | | | | | | 3024.0 |
| | SPT S-2 | 100 | 35 50/2" | 60/2" | | | BASALT, gray, vesicular, porphritic aphanitic | |
| 5.7 | | | | | | | | 3023.3 |

Refusal at 5.7 feet on basalt.
Bottom of borehole at 5.7 feet.

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Bend, OR 97701
(541) 382-4707

# BORING NUMBER B-03



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/22/20 **COMPLETED** 7/22/20
**GROUND ELEVATION** 3029 ft
**DRILLING CONTRACTOR** Western States Soil Conservation Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger & HQ-Wireline Coring
**AT TIME OF DRILLING** ---
**LOGGED BY** KAK **CHECKED BY** AML
**24HRS AFTER DRILLING** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS | Corrected N-Value | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | GW-GM | | [FILL], 3/4"- 0, to pea gravel | 3028.0 |
| | | | | | | | | 1.0 | |
| | | | | | | SM | | SILTY SAND, brown to tan, fine to coarse grained, subangular to subrounded | 3027.0 |
| | | | | | | | | 2.0 | |
| | CS S-1 | | | | | | | BASALT, slightly weathered to unweathered, gray with red hue, vesicular to massive, 1/16" - 1":vesicles, porphritic aphanitic, amygdaloidal in part, fractured with tan weathered faces and joints, minor infilling of joints with silty sand, R3 to R4 | |
| 5 | SPT S-2 | 100 | 50/4" | | | | | | |
| | RC C-1 | 100 (68) | | | | | | | |
| 10 | RC C-2 | 100 (15) | | | rubblized/fracture zone 10-14' bgs | | | | |
| 15 | RC C-3 | 83 (67) | | | | | | | |
| 20 | RC C-4 | 100 (78) | | | | | | | |
| 25 | | | | | | | | 25.0 | 3004.0 |

Bottom of borehole at 25.0 feet.



Figure: A - 3

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# BORING NUMBER B-04



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3030 ft
**DRILLING CONTRACTOR** Western States Soil Conservation Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger & HQ-Wireline Coring
**AT TIME OF DRILLING** ---
**LOGGED BY** KAK **CHECKED BY** AML
**24HRS AFTER DRILLING** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | REMARKS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|
| 0 | | | | SM | | SILTY SAND, brown to tan, fine to coarse grained, subrounded to subangular, pumiceous | 3028.5 |
| 1.5 | | | | | | BASALT, unweathered to highly weathered, gray with red hue, vesicular to massive in part, 1/16' - 1" vesicles, porphritic aphanitic, amygdaloidal in part, calcite filled amygdales, tan weathered surfaces, R1 to R4 | |
| 5 | | | | | | | |
| 10 | RC C-1 | 100 (62) | | | | | |
| 15 | RC C-2 | 100 (87) | | | | | |
| 20 | RC C-3 | 100 (35) | highly fractured 17-18' bgs brown soil infilling fractures | | | | |
| 25 | RC C-4 | 100 (77) | | | | | |
| 25.0 | | | | | | | 3005.0 |

Bottom of borehole at 25.0 feet.

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Figure: A - 4

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# BORING NUMBER B-05



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/20/20 **COMPLETED** 7/20/20
**GROUND ELEVATION** 3043 ft
**DRILLING CONTRACTOR** Western States Soil Conservation Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** KAK **CHECKED BY** AML
**24HRS AFTER DRILLING** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS | Corrected N-Value | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | SM | | SILTY SAND, brown to tan, fine to coarse grained, subangular to subrounded, pumiceous | 3041.5 |
| 1.5 | SPT S-1 | 100 | 50/2" | 60/2" | | | BASALT, gray | 3041.4 |
| 1.6 | | | | | | | Refusal at 1.6 feet on basalt.<br>Bottom of borehole at 1.6 feet. | |

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# BORING NUMBER B-06



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/20/20 **COMPLETED** 7/20/20
**GROUND ELEVATION** 3046 ft
**DRILLING CONTRACTOR** Western States Soil Conservation Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** KAK **CHECKED BY** AML
**24HRS AFTER DRILLING** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS | Corrected N-Value | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | SM | | SILTY SAND, brown to tan, fine to coarse grained, subangular to subrounded, pumiceous | 3045.0 |
| 1.0 | SPT S-1 | 100 | 50/1" | 60/1" | | | BASALT, gray | 3044.9 |
| 1.1 | | | | | | | Refusal at 1.1 feet on basalt.<br>Bottom of borehole at 1.1 feet. | |



Figure: A - 6

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# BORING NUMBER B-07



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/20/20 **COMPLETED** 7/20/20
**GROUND ELEVATION** 3043 ft
**DRILLING CONTRACTOR** Western States Soil Conservation Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** KAK **CHECKED BY** AML
**24HRS AFTER DRILLING** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|
| 0 | | SM | | SILTY SAND, brown to tan, fine to coarse grained, subangular to subrounded, pumiceous | 3042.5 |
| 0.5 | | | | Refusal at 0.5 feet on basalt.<br>Bottom of borehole at 0.5 feet. | |



Figure: A - 7

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# BORING NUMBER B-08



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/22/20 **COMPLETED** 7/22/20
**GROUND ELEVATION** 3040 ft
**DRILLING CONTRACTOR** Western States Soil Conservation Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger & HQ-Wireline Coring
**AT TIME OF DRILLING** ---
**LOGGED BY** KAK **CHECKED BY** AML
**24HRS AFTER DRILLING** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS | Corrected N-Value | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | GW-GM | | [FILL], pea gravel, gray to red | |
| | | | | | | | | 1.0 | 3039.0 |
| | | | | | | | | SILTY SAND, medium dense, moist, brown to tan, subangular to subrounded | |
| 5 | SPT S-1 | 100 | 14<br>10<br>8 | 22 | Fines: 19.4<br>MC: 15.7 | SM | | | |
| 10 | SPT S-2 | 100 | 13<br>16<br>20 | 43 | | | | | |
| 15 | | | | | | | | 15.0 | 3025.0 |
| | SPT S-3 | 100 | 10<br>15<br>18 | 40 | | | | POORLY GRADED SAND WITH SILT, dense, moist, blackish brown to dark tan, subrounded to rounded, sand sized fragments of basalt, cinder, scoria, and pumice | |
| 20 | SPT S-4 | 100 | 11<br>14<br>18 | 38 | Fines: 6.4<br>MC: 14.4 | SP-SM | | | |
| 25 | SPT S-5 | 100 | 23<br>50/4" | 60/4" | | | | 25.5 | 3014.5 |
| | | | | | | | | 25.8 BASALT, gray | 3014.2 |

Bottom of borehole at 25.8 feet.



Figure: A - 8

# KEY TO SYMBOLS

The Wallace Group
62915 NE 18th Street, Suite 1
Bend, OR 97701
(541) 382-4707

**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR

## LITHOLOGIC SYMBOLS
## (Unified Soil Classification System)


FILL: Fill (artificial fill)


GP-GM: USCS Poorly-graded Gravel with Silt


SM: USCS Silty Sand

## SAMPLER SYMBOLS


Grab Sample

## WELL CONSTRUCTION SYMBOLS

## ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
FINES - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)
OC - ORGANIC CONTENT (%)

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UCCS - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION
Water Level at Time of Drilling, or as Shown
Water Level at End of Drilling, or as Shown
Water Level After 24 Hours, or as Shown



Figure: A

# TEST PIT NUMBER TP-01



The Wallace Group
62915 NE 18th Street, Suite 1
Bend, OR 97701
(541) 382-4707

**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3040 ft
**EXCAVATION CONTRACTOR** Terry Shine Excavating
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Mini-Excavator
**AT TIME OF EXCAVATION** ---
**LOGGED BY** SMW **CHECKED BY** AML
**24HRS AFTER EXCAVATION** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|
| 0.0 | | SM | | SILTY SAND WITH GRAVEL, moist to dry, brown, fine to coarse grained, angular to subangular, organics | 3039.5 |
| 0.5 | | | | Refusal at 0.5 feet on basalt.<br>Bottom of test pit at 0.5 feet. | |

# TEST PIT NUMBER TP-02



The Wallace Group
62915 NE 18th Street, Suite 1
Bend, OR 97701
(541) 382-4707

**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3027 ft
**EXCAVATION CONTRACTOR** Terry Shine Excavating
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Mini-Excavator
**AT TIME OF EXCAVATION** ---
**LOGGED BY** SMW **CHECKED BY** AML
**24HRS AFTER EXCAVATION** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|
| 0.0 | | SM | | SILTY SAND WITH GRAVEL, moist, brown, fine to coarse grained, angular to subangular, [FILL], boulder fill / graded rock and soil, boulders to 2.5' diameter, trace plastic and refuse | |
| 2.5 | | | | | |
| 3.0 | | | | | 3024.0 |

Refusal at 3.0 feet on basalt.
Bottom of test pit at 3.0 feet.

The Wallace Group
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Bend, OR 97701
(541) 382-4707

# TEST PIT NUMBER TP-03



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3028 ft
**EXCAVATION CONTRACTOR** Terry Shine Excavating
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Mini-Excavator
**AT TIME OF EXCAVATION** ---
**LOGGED BY** SMW **CHECKED BY** AML
**24HRS AFTER EXCAVATION** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|
| 0.0 | | SM | | SILTY SAND WITH GRAVEL, brown, [FILL], trash, bottles, metal, cables, washing machine, residential waste | |
| 2.5 | | | | | |
| 4.5 | | | | | 3023.5 |

Refusal at 4.5 feet on basalt.
Bottom of test pit at 4.5 feet.

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Bend, OR 97701
(541) 382-4707

# TEST PIT NUMBER TP-04



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3040 ft
**EXCAVATION CONTRACTOR** Terry Shine Excavating
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Mini-Excavator
**AT TIME OF EXCAVATION** ---
**LOGGED BY** SMW **CHECKED BY** AML
**24HRS AFTER EXCAVATION** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | |
| | GB S-1 | 100 | Fines: 6.7<br>MC: 4.7 | GP-GM | | POORLY GRADED GRAVEL WITH SILT AND SAND, moist to dry, brown, fine to coarse grained, angular to subangular | |
| 2.0 | | | | | | | 3038.0 |

Refusal at 2.0 feet on basalt.
Bottom of test pit at 2.0 feet.

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(541) 382-4707

# TEST PIT NUMBER TP-05



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3046 ft
**EXCAVATION CONTRACTOR** Terry Shine Excavating
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Mini-Excavator
**AT TIME OF EXCAVATION** ---
**LOGGED BY** SMW **CHECKED BY** AML
**24HRS AFTER EXCAVATION** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|
| 0.0 | | SM | | SILTY SAND WITH GRAVEL, moist, brown, fine to coarse grained, angular to subangular | |
| 1.0 | | | | | 3045.0 |

Refusal at 1.0 feet on basalt.
Bottom of test pit at 1.0 feet.

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Bend, OR 97701
(541) 382-4707

# TEST PIT NUMBER TP-06



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3040 ft
**EXCAVATION CONTRACTOR** Terry Shine Excavating
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Mini-Excavator
**AT TIME OF EXCAVATION** ---
**LOGGED BY** SMW **CHECKED BY** AML
**24HRS AFTER EXCAVATION** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | DCP BLOW COUNTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|
| 0.0 | | | 5<br>21<br>29 | SM | | SILTY SAND WITH GRAVEL, medium dense, moist, brown, fine to coarse grained, angular to subangular | |
| | GB S-1 | 100 | | | | | |
| 2.0 | | | | | | | 3038.0 |

Refusal at 2.0 feet on basalt.
Bottom of test pit at 2.0 feet.

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Bend, OR 97701
(541) 382-4707

# TEST PIT NUMBER TP-07



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3045 ft
**EXCAVATION CONTRACTOR** Terry Shine Excavating
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Mini-Excavator
**AT TIME OF EXCAVATION** ---
**LOGGED BY** SMW **CHECKED BY** AML
**24HRS AFTER EXCAVATION** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | DCP BLOW COUNTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|---|---|
| 0.0 | | | 22<br>41<br>52 | SM | | SILTY SAND WITH GRAVEL, dense, moist, brown, fine to coarse grained, angular to subangular | |
| 2.5 | GB S-1 | 100 | | | | | |
| 3.0 | | | | | | Refusal at 3.0 feet on basalt.<br>Bottom of test pit at 3.0 feet. | 3042.0 |



Figure: A - 15

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Bend, OR 97701
(541) 382-4707

# TEST PIT NUMBER TP-08



**CLIENT** CEC, Inc.
**PROJECT NAME** Negus Recycling & Transfer Facility
**PROJECT NUMBER** 11301-1
**PROJECT LOCATION** Redmond, OR
**DATE STARTED** 7/21/20 **COMPLETED** 7/21/20
**GROUND ELEVATION** 3045 ft
**EXCAVATION CONTRACTOR** Terry Shine Excavating
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Mini-Excavator
**AT TIME OF EXCAVATION** ---
**LOGGED BY** SMW **CHECKED BY** AML
**24HRS AFTER EXCAVATION** ---
**NOTES**

| DEPTH (ft) | SAMPLE TYPE NUMBER | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | Approximate Elevation |
|---|---|---|---|---|---|
| 0.0 | | SM | | SILTY SAND, moist, brown, fine to coarse grained, subangular to subrounded, organics, cobbles and boulders at surface | 3044.5 |
| 0.5 | | | | Refusal at 0.5 feet on basalt.<br>Bottom of test pit at 0.5 feet. | |

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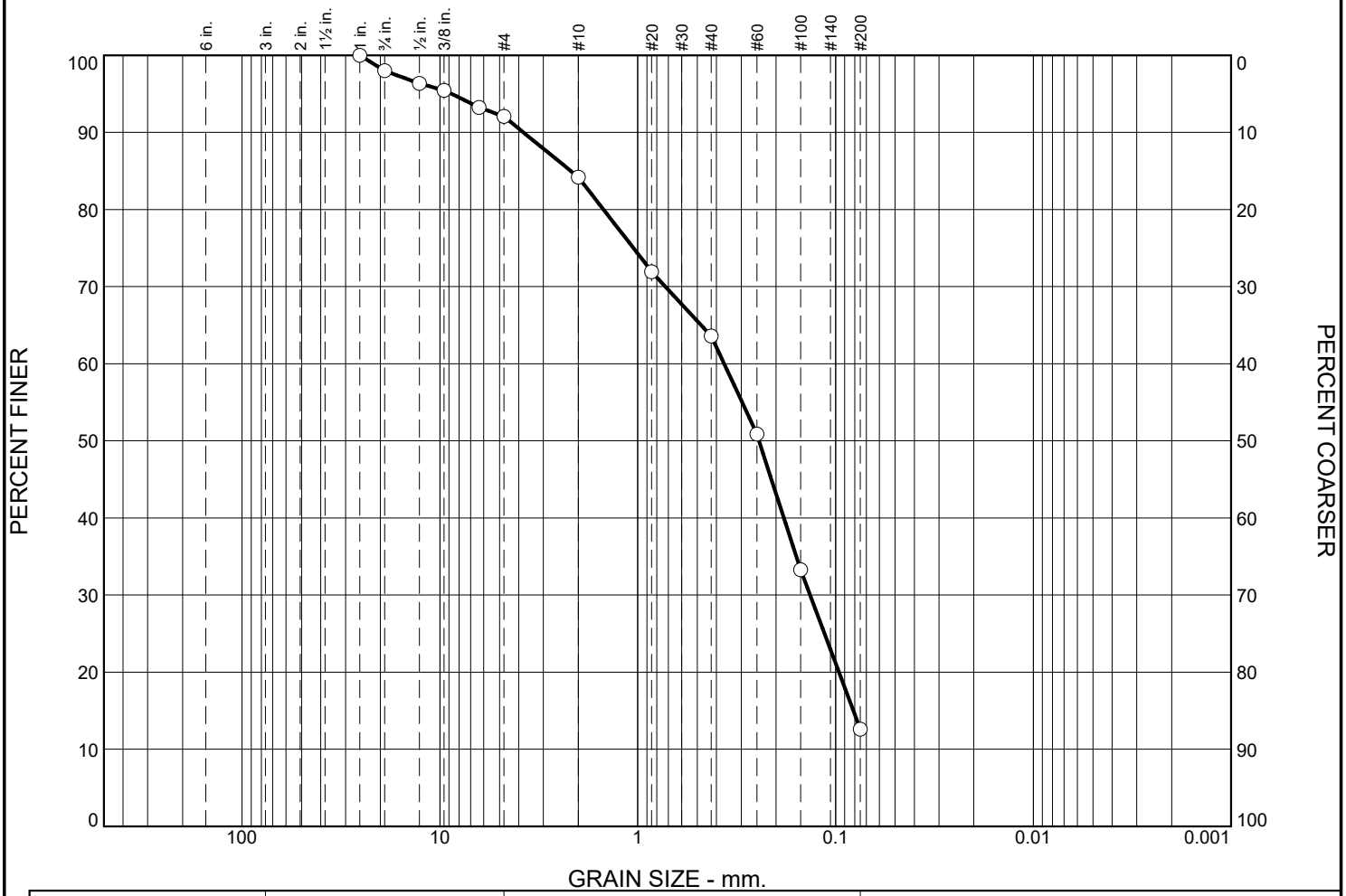
# APPENDIX B

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 2.0 | 5.9 | 7.9 | 20.6 | 51.0 | 12.6 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | Not Tested | Not Tested | 2.1841 | 0.3660 | 0.2438 | 0.1344 | 0.0813 | | | |

| MATERIAL DESCRIPTION | TEST DATE | USCS | NM |
|---|---|---|---|
| ○ Silty Sand | 07-28-20 | SM | 21.6 % |

**Project No.** 11301-1 **Client:** CEC, Inc.

**Project:** Negus Recycling & Transfer Facility

○ **Source of Sample:** B-01 **Depth:** 5' **Sample Number:** S-1

**Remarks:**

○ Lab No.: WGG0176

Sampled By: KAK

Date Sampled: 07-21-20

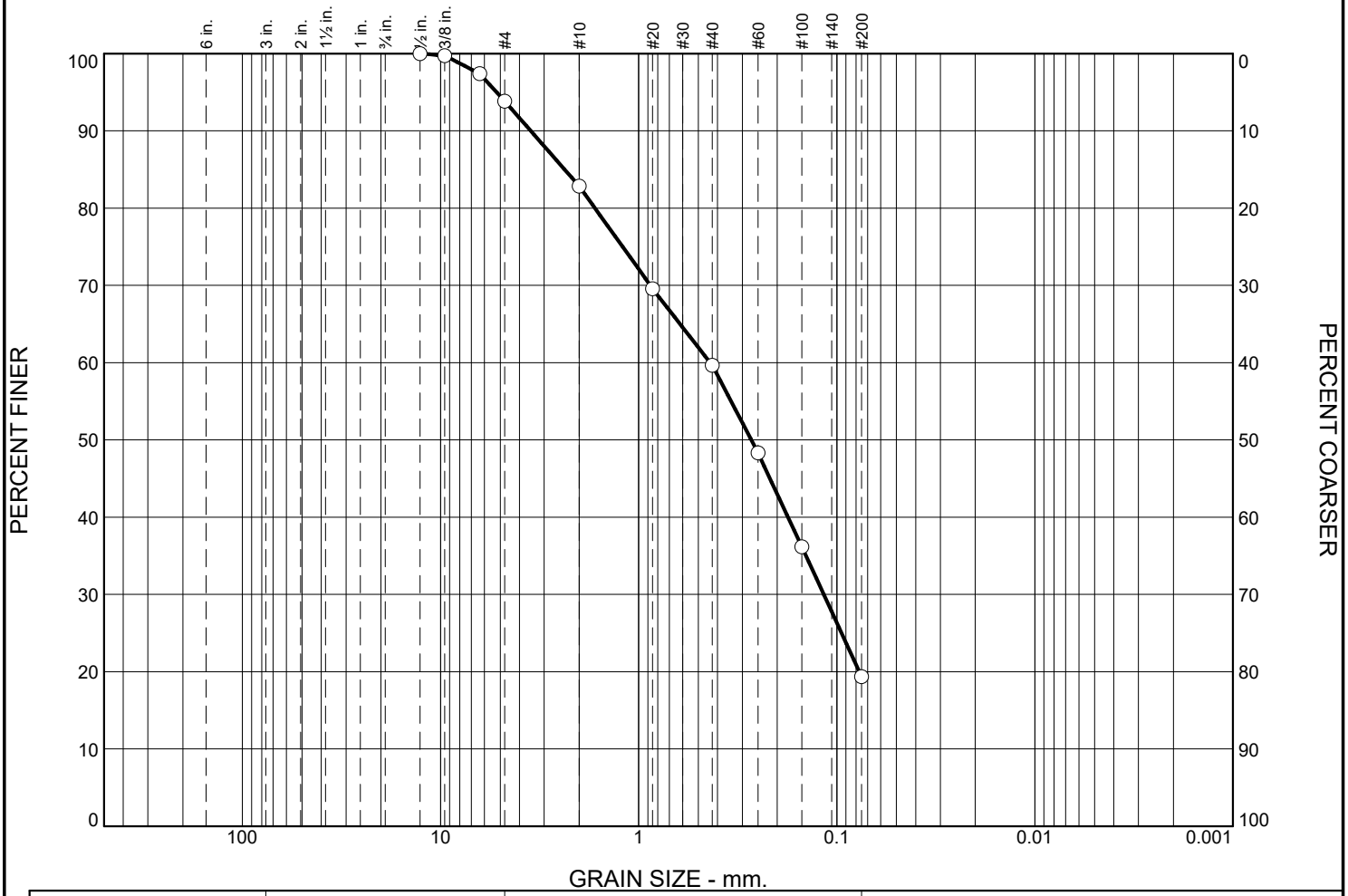
**The Wallace Group, Inc.**

**Bend, Oregon**

**Figure** B-1

**Tested By:** PJH **Checked By:** AML

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 6.2 | 11.0 | 23.1 | 40.3 | 19.4 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | Not Tested | Not Tested | 2.3704 | 0.4355 | 0.2705 | 0.1163 | | | | |

| MATERIAL DESCRIPTION | TEST DATE | USCS | NM |
|---|---|---|---|
| ○ Silty Sand | 07-27-20 | SM | 15.7 % |

**Project No.** 11301-1 **Client:** CEC, Inc.

**Project:** Negus Recycling & Transfer Facility

○ **Source of Sample:** B-08 **Depth:** 5' **Sample Number:** S-1

**Remarks:**

○ Lab No.: WGG0176

Sampled By: KAK

Date Sampled: 07-22-20

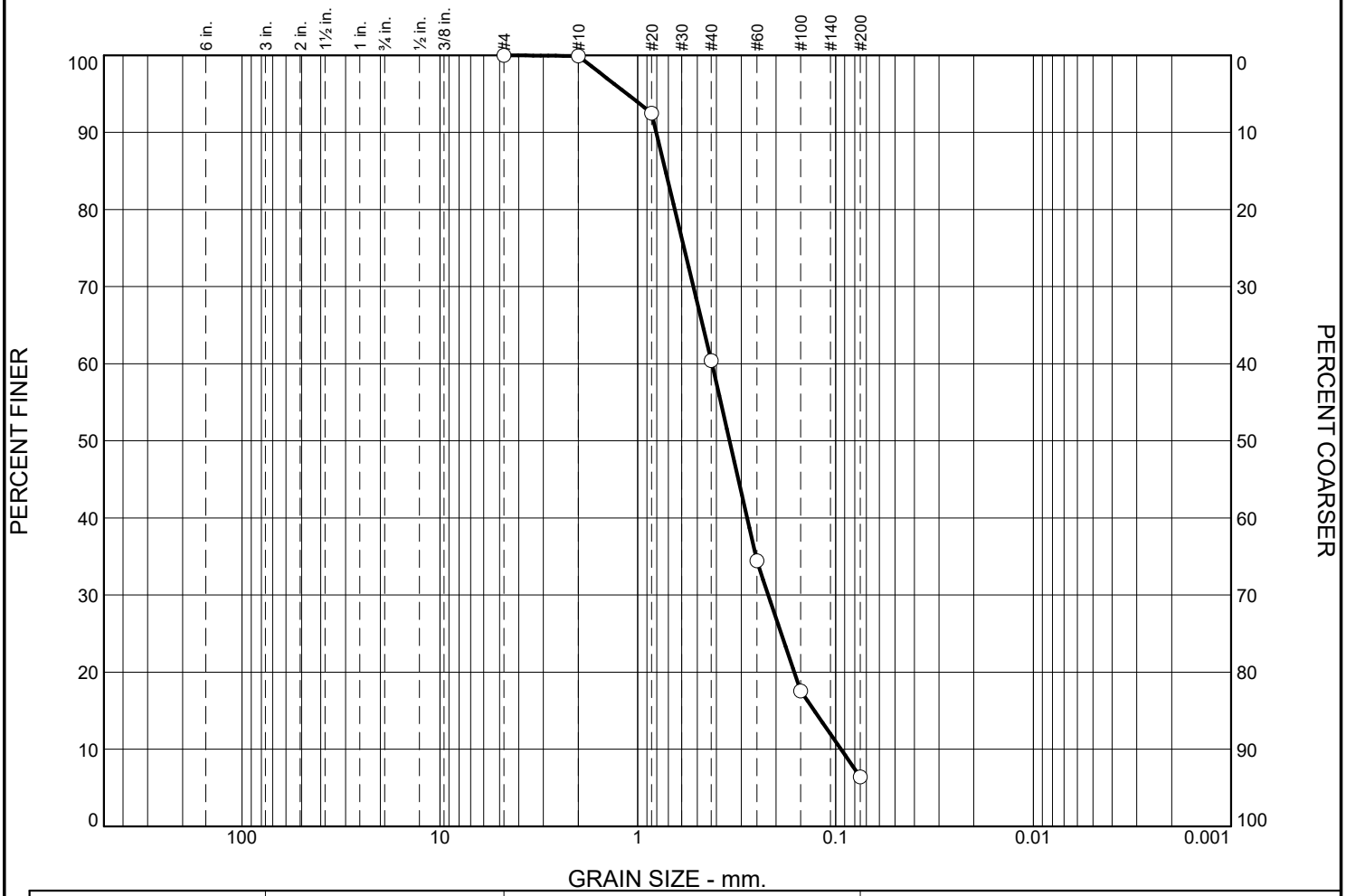
**The Wallace Group, Inc.**

**Bend, Oregon**

**Figure** B-2

**Tested By:** PJH **Checked By:** AML

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 39.5 | 54.0 | 6.4 | |
| | | | | | | | | |
| | | | | | | | | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | Not Tested | Not Tested | 0.7230 | 0.4215 | 0.3437 | 0.2187 | 0.1280 | 0.0938 | 1.21 | 4.49 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | TEST DATE | USCS | NM |
|---|---|---|---|
| ○ Poorly Graded Sand with Silt | 07-27-20 | SP-SM | 14.4 % |

**Project No.** 11301-1 **Client:** CEC, Inc.

**Project:** Negus Recycling & Transfer Facility

○ **Source of Sample:** B-08 **Depth:** 20' **Sample Number:** S-4

**Remarks:**

○ Lab No.: WGG0176

Sampled By: KAK

Date Sampled: 07-22-20

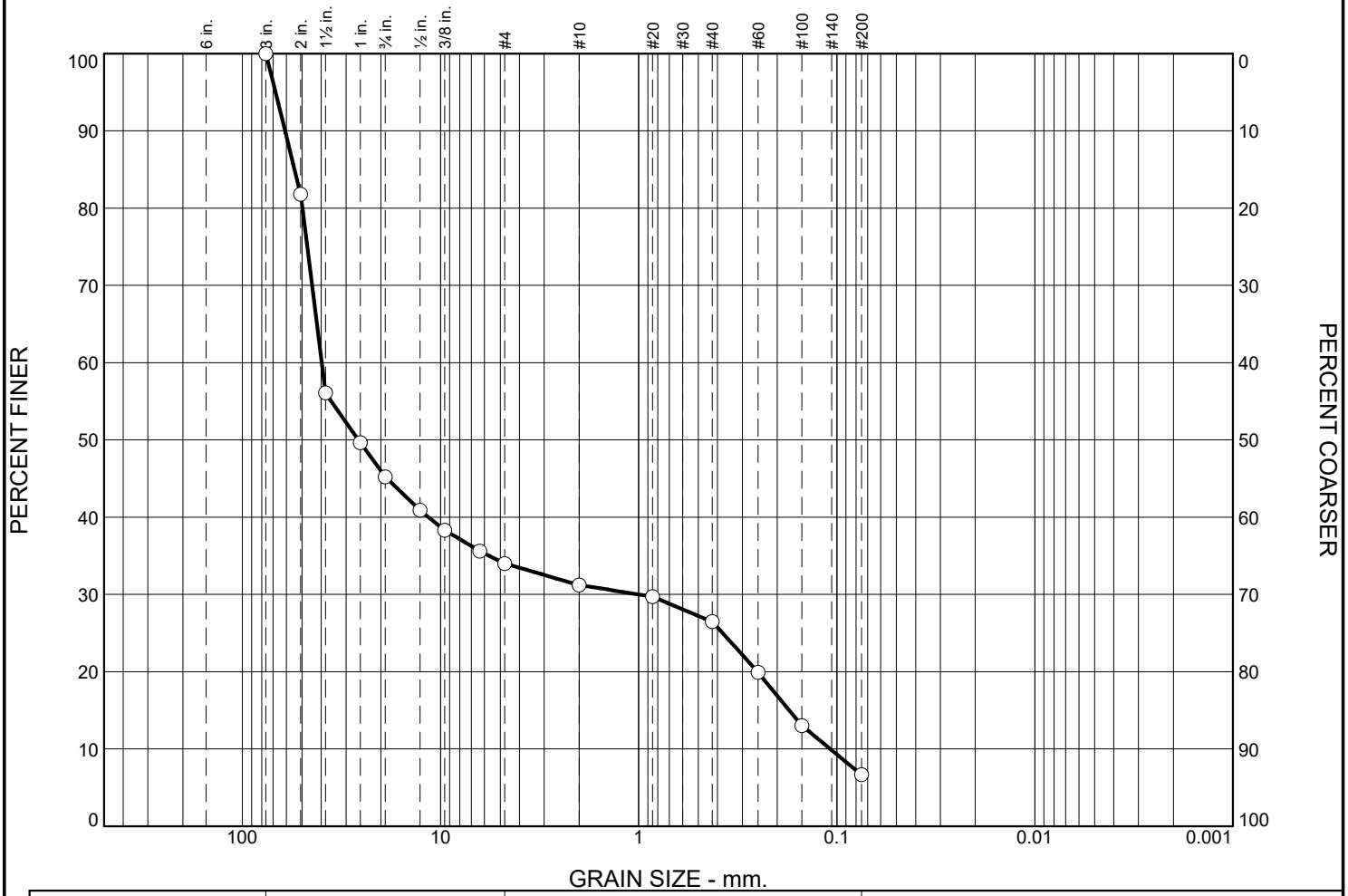
**The Wallace Group, Inc.**

**Bend, Oregon**

**Figure** B-3

**Tested By:** PJH **Checked By:** AML

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 54.8 | 11.2 | 2.8 | 4.7 | 19.8 | 6.7 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | Not Tested | Not Tested | 54.5686 | 39.8119 | 26.0049 | 0.9987 | 0.1736 | 0.1080 | 0.23 | 368.75 |

| MATERIAL DESCRIPTION | TEST DATE | USCS | NM |
|---|---|---|---|
| ○ Poorly Graded Gravel with Silt and Sand | 07-27-20 | GP-GM | 4.7 % |

**Project No.** 11301-1 **Client:** CEC, Inc.

**Project:** Negus Recycling & Transfer Facility

○ **Source of Sample:** TP-04 **Depth:** 1' **Sample Number:** S-1

**Remarks:**

○ Lab No.: WGG0176

Sampled By: KAK

Date Sampled: 07-20-20

**The Wallace Group, Inc.**

**Bend, Oregon**

**Figure** B-4

**Tested By:** PJH **Checked By:** AML

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# APPENDIX C

# ASCE 7 Hazards Report

**Address:**
No Address at This Location

| | | | |
|---|---|---|---|
| **Standard:** | ASCE/SEI 7-16 | **Elevation:** | 3045.88 ft (NAVD 88) |
| **Risk Category:** | II | **Latitude:** | 44.29045 |
| **Soil Class:** | B - Estimated (see Section 11.4.3) | **Longitude:** | -121.14137 |

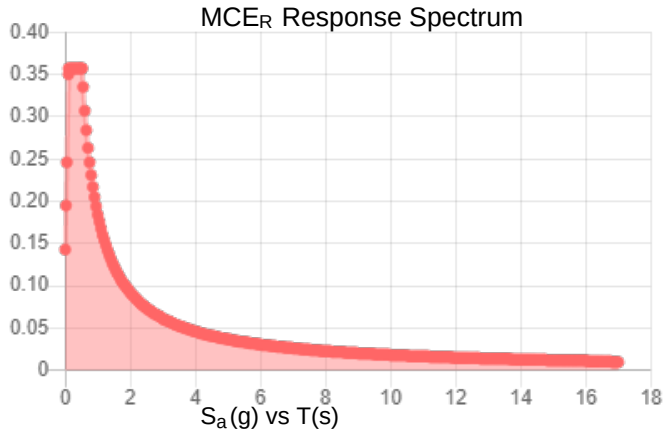

# Seismic

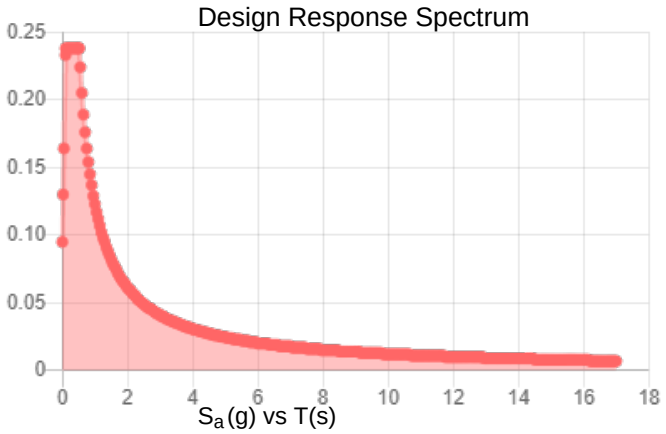
**Site Soil Class:** B - Estimated (see Section 11.4.3)

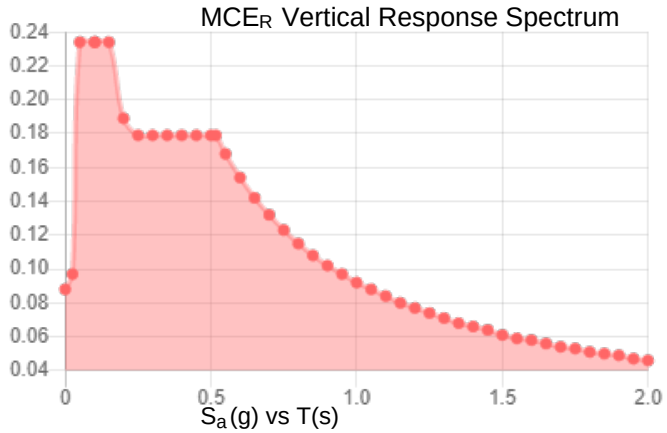
**Results:**

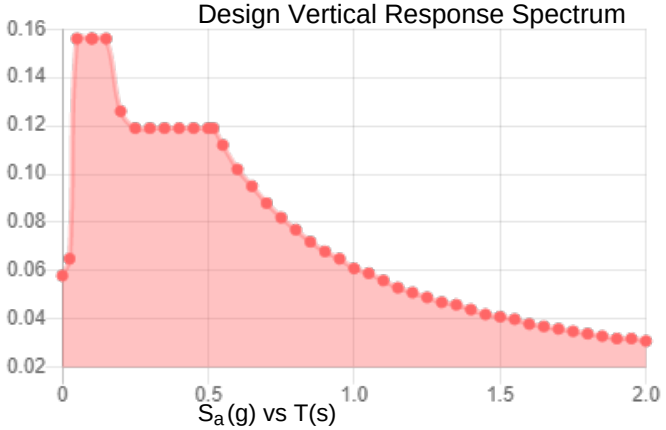
| | | | |
|---|---|---|---|
| $S_S$ : | 0.357 | $S_{D1}$ : | 0.123 |
| $S_1$ : | 0.184 | $T_L$ : | 16 |
| $F_a$ : | 1 | PGA : | 0.162 |
| $F_v$ : | 1 | $PGA_M$ : | 0.162 |
| $S_{MS}$ : | 0.357 | $F_{PGA}$ : | 1 |
| $S_{M1}$ : | 0.184 | $I_e$ : | 1 |
| $S_{DS}$ : | 0.238 | $C_v$ : | 0.819 |

**Seismic Design Category** B




**Data Accessed:** Wed Jul 22 2020

**Date Source:** USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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# APPENDIX D

Existing site conditions during exploration. View looks northwest.

Geotechnical exporations performed with track-mounted CME-75 by Western States Soil Conservation Inc.

Hollow stem auger flights were advanced until practical refusal.


HQ-wireline coring techniques were used to obtain core samples once auger refusal was encountered.

Test pit operation using mini-excavator operated by Terry Shine Excavation.


TP-02 spoils with boulders and refuse.